PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

HELD AT PHILADELPHIA

FOR

PROMOTING USEFUL KNOWLEDGE

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VOL. XII. JANUARY TO JULY, 1871. No. 86.

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PROCEEDINGS

OF THE

AMERICAN PHILOSOPHICAL SOCIETY

VOL. XII. 1871. No. 86

Stated Meeting, January 6.

Present, seventeen members.

GEO. B. WOOD, President, in the Chair.

Mr. Eckley Coxe, lately elected, was presented to the presiding officer and took his seat.

The resignation of Dr. D. F. Condie on account of ill health was received, and accepted.

A photograph of Mr. Thomas Davidson, dated Geological Society, Somerset House, London, Dec. 6, 1870, was received.

Letters of acknowledgment were received from the London Geological Society (Proceedings No. 82); the Smithsonian Institution (83); and the Swiss Society at Berne, dated November, 1869 (Proceedings, vols. X and XI).

Donations for the Library were received from the Moscow N. H. S., Boston Geological Society, Swiss Society, Bavarian Academy, R. Institution of G. B., London Meteorological, Chemical and Geological Societies, Leeds Philosophical Society, R. Dublin Society, Peabody Museum at Boston, Boston N. H. S., Silliman's Journal, American Antiquarian Society, Franklin Institute, College of Physicians, Penn Monthly, U. S. Observatory, the Treasury Bureau, and Editors of Nature.

The decease of Wm. Chauvenet of St. Louis, a member of the Society, at St. Paul, Dec. 13, 1870, was announced by the Secretary.

The decease of Joshua J. Cohen, a member of the Society, at Baltimore, November 4, 1870, aged 70 years, was announced by Prof. Trego.

The decease of Albert Barnes, a member of the Society, at Philadelphia, Dec. 24, 1870, aged 72 years, was announced by Mr. Fraley.

Dr. Geo. B. Wood communicated the results of experiments on the best method of reviving fruit trees.

Prof. Cope communicated the discovery of a new genus of fish from the Green River Country.

Mr. Chase described the methods adopted by the Meteorological Board of the Royal Society, which he had lately visited in London.

The Report of the Judges and Clerks of the annual election was read, by which the following members were declared duly elected to fill the respective offices of the Society for the ensuing year.

President.

George B. Wood.

Vice Presidents.

John C. Cresson, Isaac Lea, Frederick Fraley.

Secretaries.

Charles B. Trego, John L. LeConte,
E. Otis Kendall, J. P. Lesley.

Curators.

Hector Tyndale, Elias Durand, Joseph Carson.

Treasurer.

Charles B. Trego.

Counsellors to serve three years.

Isaac Hays, Henry C. Carey,
Robert E. Rogers, Robert Bridges.

Mr. Lesley was nominated Librarian.

Pending nominations for membership, Nos. 661 to 668 were read.

The Publication Committee reported upon the subject of the publication of Dr. H. C. Wood's Memoir of the Fresh Water Algæ of the United States.

The Report of the Finance Committee, postponed from the last meeting, was read by its Chairman, Mr. Fraley; and the sums recommended by the Committee were, on motion, appropriated for the expenses of the ensuing year. A further recommendation to increase the insurance on the Hall, was on motion adopted; and the meeting was adjourned.

Revival of Fruit Trees *prematurely ceasing to bear fruit, or prematurely decaying*, by Geo. B. Wood, M. D.

(*Communicated to the American Philosophical Society*, January 6, 1871.)

It is well known that most fruit trees, especially the peach and apple trees, in sites where they have been long cultivated, often cease to bear fruit, and even perish, long before their natural period. Thus the peach, which has a normal life of 50 or 60 years, or longer, and grows under favourable circumstances to the size of a considerable tree, generally, in this part of the United States, ceases to bear fruit after two or three years of productiveness, and soon after begins to decay, seldom living beyond 15 or 20 years. The apple tree also, long before it has attained its normal length of life, often ceases to yield fruit, either for a time or permanently, without apparent cause; and trees, planted on the site of an old orchard which has been removed, not unfrequently refuse to bear at all, or at least to a profitable extent.

It is obviously of great importance to discover the cause or causes of such failures, and, if possible, to apply a remedy or preventive. Unless I greatly deceive myself, I have succeeded in showing that the evil generally has its source in a deficiency of the salts of potassa in the soil, and may be corrected by supplying that deficiency.

The alkali potassa, in combination generally with one or another of the vegetable acids, is an essential ingredient in all plants, excepting the sea plants, in which its place is supplied by soda. In living vegetables it is contained dissolved in the juice, and is consequently most abundant in the most succulent parts; and, when the plants are burned, the alkali is left behind in the ashes, of which it constitutes an exceedingly variable proportion, according to the peculiar plant or part of the plant burned. Thus, while the ashes of oak wood contain only about 3 parts in 1000, those of the common poke, the growing wheat stalk, and the potato stems, contain 48 or 50 parts or more. The greater portion by far of the alkali is in the state of carbonate, with a little in the caustic state, and being, in these conditions, very soluble in water, is extracted by lixiviation

with water, and obtained by evaporating the ley. A much smaller portion is in the form of silicate, which is left behind in the ashes after lixiviation, and gives to the soap-boilers' ashes almost all if not quite all their value as a manure. It is, however, only the fresh-burned ashes, not yet submitted to lixiviation, and consequently still containing the potash in its soluble state, that is applicable to the purpose of supplying the alkali to fruit trees in the mode in which I employ it.

When plants are no longer supplied with the requisite amount of potash, they cease to grow, and at length generally perish. In the case of the succulent fruit trees, as the alkali is required in the largest proportion in the fruit, this is the first to suffer; then the leaves gradually fail; and at length the whole tree dies, limb after limb.

How I came to discover this source of premature failure of fruit trees, and to supply the deficiency by means of the soluble potash contained in fresh ashes, I explained, so far as the peach tree is concerned, in a communication made last year to the Society, which was published in the Proceedings.

In that communication I stated that, believing with most others that the peach tree perishes prematurely, in consequence of being attacked near the root by a species of worm, I employed as a remedy against this parasite, after scraping as far as possible the worm out of the root with a knife, fresh ashes in an excavation about the stem of the plant; supposing that, by their caustic power, they might destroy any remains of the insect or its eggs. This method was not original with myself; as I had seen it practiced in my youth very effectually in keeping a peach orchard in bearing for several years.

The peach trees on which I tried the experiment had long ceased to bear fruit, and were in the last stage of decay; in several instances one or more branches being absolutely dead, and the stem being covered with lichens, as is apt to happen with dying trees.

This was done in the Autumn; the earth having been removed around the stem of each tree to the depth of four or five inches, so as to lay bare the upper surface of the main roots, and the excavation filled with fresh ashes. Next Spring a marvellous change was experienced by the trees. They had recovered more than the vigor of their early life, and bore fruit in an abundance which I had rarely, if ever, witnessed.

I could not conceive that such a result should proceed so rapidly, from the destruction of a few worms. Besides, some of the trees had no worms that could be observed; and yet they had been as far gone, and were as much revived as the others.

I was, therefore, driven to the conclusion, that the ashes had not acted by destroying the worm, but by furnishing to the trees a material necessary to their existence, and from the want of which they were perishing. This could only be the soluble potash contained in the ashes, which being dissolved by the rain, was carried in solution along the roots to the minute rootlets where it was needed.

One important inference, which may be here incidentally mentioned, is

that the peach trees were not dying from the worms, but that these attacked them because they were dying from other causes; and it is probably true, as a general rule, that plants in perfect health are in a condition to protect themselves against destructive parasites, probably because the salts of potash in their vessels are repulsive or even destructive to the parasites, which destroy the plant in the absence of this defense. I am not certain even that the curculio may not attack certain fruits, the plum for example, in consequence of deficiency of the alkali in its juice.

At first my experiments were confined to the peach tree; but it may be remembered that I said in my communication to the Society that the principle was applicable as well to other fruit trees, especially the apple, which often refuses to bear, apparently capriciously, but probably from the same deficiency of potash in the soil.

Last year I had the opportunity of testing the correctness of this supposition. I happened to have two apple orchards; one of them old, perhaps 60 years or more, the other comparatively young, having been planted, 15 or 20 years since, upon a piece of ground which had previously been the site of an apple orchard for I presume nearly a century. Both of these orchards might be considered as nearly or quite barren; the old orchard not having borne fruit of any account for 5 or 6 years; and the young one having never borne at all.

In the Autumn of 1869, I tried with these trees the same experiments as in the Autumn before I had tried with the peach trees. The earth was dug from around their stems to the depth of about 5 inches, and the excavation filled, in each case, with about half a bushel of fresh ashes. As regards the old orchard, a part was allowed to remain without treatment, so as to secure the effect of contrast. In the following Spring and Summer (1870), my expectations were fully realized. Early in the season a striking difference was observed between the trees not treated with ashes and those which had been so treated. A dividing line could be observed between the two sections of the orchard; the trees which had been ashed being forward both in leaf and blossom, while the others had made little progress; and the same contrast was presented in the fruit; the trees left to themselves continuing barren, while the ashed trees were loaded with apples. The young orchard, which had never borne fruit of any account, was also made for the first time very productive.

A similar experiment I tried on several fruit trees of different kinds in my garden in town. Though the ashes were applied in Spring instead of of Autumn, the trees in the growing season gave evidence of a similar result. The trees were richly covered with blossoms, which were just becoming exchanged for young fruit, when the famous hail storm which proved so destructive in this city last Summer, put an end to the experiment by stripping the trees of blossom and fruit, and to a great extent even of their leaves.

Among the trees was a very old Newtown pippen tree, probably of not

less than three-quarters of a century, which had for years ceased to bear, or at best only now and then brought forth a small knotty fruit unfit for use. The tree had been dying branch by branch every year, until reduced almost to the original stem, with a few branches above. This tree appeared in the warm season to have renewed its youth. It was richly loaded with flowers and fruit, and gave hopes of an abundant product in the Autumn. It suffered, however, like the others from the storm; very few of the blossoms or young fruit remaining still attached. One of these went on to full size; and the handsome Newtown pippen which I now exhibit to the members as the sole relict of the storm, shows what the product might have been had not the hail interfered.

I consider that the efficiency of potassa in the revival of fruit trees has been satisfactorily demonstrated by the foregoing experiments, at least in relation to the peach and apple trees, and I may add also the pear and quince, several of which were treated in the same way and with similar results.

As to the securing of the plum and other fruits against the curculio, I think it highly probable that this also may be done by ashes, on the principle already stated, but I can adduce no proof of the fact; for, in the only instance in which ashes were applied to a plum, though the tree showed its effects by a copious growth of leaves and flowers, and even of young fruit; yet the destruction of these by the hail storm prevented the completion of the experiment; and for the determination of this point, which is an important one, we shall have to wait another year.

But, important as I consider the discovery of the reviving power of potassa in the case of failing fruit trees, I attach much greater value to its influence in another direction, which has suggested itself in the prosecution of the foregoing experiments. It is an unfortunate fact, with which the farmers of my own country neighbourhood are unhappily but too familiar, that certain cereal crops, especially that of wheat, have for some years failed to be remunerative. Where wheat formerly yielded 20 bushels or more to the acre, it can now seldom be made to produce more than 12 or 15 bushels.

In examining into the relative proportion of potassa contained in the ashes of different plants, I was surprised to find that, while the ashes of the common fire wood, as the oak, maple, &c., contain from about 2 to 4 parts in 1000, the wheat stalk yields 47 parts. Now, while this fact shows the extraordinary demand of growing wheat for potassa, it suggests also that the failure of this crop of late may be owing to the same deficiency of the salts of potassa in the soil which has caused the premature destruction of the peach; and, though the manure employed in the cultivation of wheat contains potassa, yet it does not yield as much of this alkali as the plant requires for its greatest productiveness; few of the vegetables that unite in the constitution of manure containing so large a proportion as wheat. To meet this demand of wheat, I propose to employ unleached ashes in the cultivation of this cereal. Leached ashes, though containing but a small proportion of potassa, and that chiefly in the form

of insoluble silicate, have nevertheless been found one of the best fertilizers for wheat; and the unleached, if properly applied, would probably produce a much greater effect. This is as yet conjectural; but I have instituted an experiment which I hope may determine the point.

In the early Autumn I caused an acre of ground to be prepared for a wheat crop. It was divided into three parts, one of which was to be treated with fresh ashes exclusively, another with ashes and swamp muck, and the third with muck alone. The part treated with fresh ashes exclusively was first ploughed, and then sown with wheat and ashes, and finally harrowed; the ashes being applied to the surface, so that its potassa when dissolved by the rain should be in immediate contact with the germinating seed; instead of being ploughed in, as ordinary leached ashes are. The second part, after being covered with the muck, was ploughed; and the wheat and ashes were applied as before. The third part was simply treated with muck, then ploughed and sown with wheat.

The result of this experiment cannot be determined until the time of the wheat harvest next Summer; but, thus far, it is decidedly in favor of the ashes; the two-thirds which were treated with this material being obviously better grown than the part treated with muck alone. A glance of the eye is sufficient to show a decided line of demarcation, the ashed part being greener and further advanced than the remainder.

I have little doubt that the same remarks are equally applicable to the common potato. This is now a much less certain, and on the whole much less productive crop than formerly. I find that the potato stalks contain 55 parts of potassa in 1000 of ashes; so that the plant requires considerably more potassa than wheat. If, therefore, fresh ashes are to be a remedy for the failure of the wheat crop, they are likely to be even more so for the potato. The verification of this supposition experimentally I have reserved for the next year, when, if living, I propose to try an experiment on a large scale.

An objection to all the foregoing facts, in a practical bearing, is the question whence the ashes are to be obtained for carrying the proposition into effect on a large scale, and whether enough can be obtained for the purpose. An obvious answer to this objection is that, should ashes fail in any neighbourhood, recourse can be had to the crude potash of the shops derived from the lixiviation of the ashes of forests cleared in the course of cultivation, and, when these forests shall have all been destroyed, we may resort to the minerals containing potassa, as to the felspar in granite rocks, which contains a large proportion of that alkali.

But for a long time yet to come, and indefinitely as regards fruit trees, ashes can be obtained from the resources of the farm itself. If all the falling leaves of the woods and swamps, all the dead and dying branches or stems of trees, and all the weeds, trimmings of trees, and other rubbish of a farm be collected and burnt, enough ashes could probably be obtained annually, for an indefinite length of time, to keep all the fruit trees in full bearing.

Stated Meeting, January 20, 1871.

Present, twelve members.

GEO. B. WOOD, President, in the Chair.

A letter was received from the Illinois Industrial University at Champaign, dated Jan. 12, 1871.

Letters of envoy were received from the R. Saxon Society, and the Society of Natural Sciences at Chemnitz.

Donations for the Library were received from the Royal Academies and Societies at Berlin, Leipsig, Munich, Chemnitz, Altenburg, Quebec and Montreal; the London Astronomical, Antiquarian and Meteorological Societies; the American and Medical Journals, Prof. Greenough of Cambridge, Dr. D. D. Slade of Chestnut Hill, Mass., Prof. E. B. Andrews of Columbus, Ohio, and Gen. Tyndale.

The death of Stephen Colwell, at Philadelphia, Jan'y 15th, aged 70 years, was announced by Prof. Cresson; and on motion, Mr. Carey was appointed to prepare an obituary notice of the deceased.

The death of Dr. Edward Rhoads, at Philadelphia, Jan'y 15th, aged 29 years, was announced by Professor Trego.

Mr. Lesley was elected Librarian.

The Committee to which was referred the paper of Dr. Pepper, on a case of universal Hyperostosis, reported in favor of its publication in the Proceedings of the Society, accompanied with figures for two octavo plates, which, on motion of Prof. Cresson, was so ordered.

A communication entitled: "Computation of the effects of gradients, by Herman Haupt," was read by the Secretary.

COMPUTATION OF EFFECT OF GREDIENTS, by HERMAN HAUPT, C. E.

(*Read before the American Philosophical Society, Jan.* 20, 1871.)

When the maximum load of the same engine on any two different inclinations has been determined by experiment, the data thus furnished will suffice to calculate the load on any other inclination, the load on a level, the angle of friction at which a train will descend by gravity, the tractive power per ton of load required on a level, and the number of pounds adhesion for each ton of load.

Let R = resistance of the train on a level, which is equal to the power of the engine.

W = gross weight of train on a level.

W^1 = Weight of train on grade a.

W^2 = Weight of train on grade b.

It is proper to assume that the power required to move a train and the resistance, which is equal to it, will be in proportion to the gross weight.

The force of gravity on any inclination is in proportion to the height of the plane divided by its length, or as the rise per mile divided by 5280.

The resistance of the train W^1 being in proportion to its weight, will be expressed by $\frac{W^1}{W}R$

and the resistance of W^2 by $\frac{W^2}{W}R$

The gravity of the train W^1 on the grade $a = \frac{W^1 a}{5280}$

and of the train W^2 on the grade $b = \frac{W^2 b}{5280}$

If the engine is supposed to be loaded to the limit of its capacity on each gradient, then the power exerted must be the same as on a level and

$$\frac{W^1}{W}R + \frac{W^1 a}{5280} = R$$

$$\frac{W^2}{W}R + \frac{W^2 b}{5280} = R \quad \text{and consequently}$$

$$\frac{W^1}{W}R + \frac{W^1 a}{5280} = \frac{W^2}{W}R + \frac{W^2 b}{5280}$$

From which the value of R in terms of W W^1 and W^2 is found.

$$R = W\frac{W^2 b - W^1 a}{5280\ (W^1 - W^2)}$$

Take now the former equation $R = \frac{W^1}{W}R + \frac{W^1 a}{5280}$

from which a second value of R is obtained $= \frac{W\ W^1 a}{5280\ (W - W^1)}$

Placing these two values of R equal to each other,
there results $\frac{W^1a}{W-W^1} = \frac{W^2b-W^1a}{W^1-W^2}$

By substituting in the equation the values of W^1 W^2 a and b, as determined by observation, the values of W, or the gross load on a level can be ascertained.

By substituting the values of W W^1 W^2 a and b, the value of R on the power exerted by the engine is obtained.

By dividing this power in pounds by the gross load on a level, the tractile power per ton is determined.

As the power of an engine is always sufficient to slip the wheels on a dry rail, the adhesion is equal to the actual power exerted in moving the train and divided by the weight on drives, gives the proportion between adhesion and weight.

The angle of friction can be found when the tractive power per ton of of 2000 lbs. on a level (T) has been determined, by the equation.

Angle of friction expressed in feet per mile $= \frac{T \times 5280}{2000}$

It has been customary for engineers to consider the angle of friction as 16 to 18 feet per mile, the tractive power per ton on a level 8 pounds, and the adhesion one-eighth the weight upon the drives; but to obtain reliable data from the actual operation of roads running full trains, a letter was addressed to A. J. Cassatt, Gen'l Sup't of the Penna. R. R., who furnished the following data:

A standard 10 wheel freight engine with 3 pairs of $4\frac{1}{2}$ feet drivers with average water and coal, weighs		75,500 lbs.
Weight on drivers,		53,000 "
Weight of tender with coal and water,		50,000 "
Such an engine will haul on a moderately straight and level road 50 loaded cars of 40,000 lbs. each. Gross load,		1062 tons.
On a grade of 10 feet to the mile,	43 cars,	922 "
" "	26 " " "	35 " 762 "
" "	$52\frac{8}{10}$ " " "	17 " 402 "
" "	96 " " "	11 " 282 "

And the engine would work easier with 50 cars on the level than in either of the other cases and with most difficulty in the last.

Herman J. Lombaert, Esq., Vice President and former General Superintendent of Penna. R. R., gives as a full average load for actual work in the usual conditions of the rail.

		Tons.
Load on $52\frac{8}{10}$ ft. grade, 16 cars.	Gross load of engine,	382
" " 10 " " 40 "	" " "	862

As it is proper to allow a margin for unfavorable condition of rails, the calculations will be made on the data furnished by H. J. Lombaert.

Substituting the values of a b W^1 W^2, which are 10, $52\frac{8}{10}$, 382 and 862, the value of W, or the gross load on a level is found be 1210 tons.

The value of R or the tractive power on a level, is 11,160 lbs., or $9\frac{2}{10}$ lbs. per ton.

The angle of friction is $\frac{9.2 \times 5280}{2000} = 24.28$ feet per mile.

The adhesion is $\frac{11,160}{53,000}$ or nearly one-fifth of weight on drives.

From the data thus obtained a simple formula may be found to determine the load of the engine on any given inclination, a.

Let P = tractile power of engine on a level = 11,160 lbs.

a = feet per mile of inclination.

W^1 = weight of train on incline a, including engine and tender.

Then $W^1 \times 9.2$ = power required to move W^1 on level.

And $W^1 \frac{a}{5280}$ = gravity on incline a, in tons or $W^1 \frac{2000}{5280}$ a, in pounds.

$9.2\ W^1 + \frac{2000}{5280} W^1 a$ = power of engine = 11,160 lbs.

Or $W^1 = \frac{11,160}{9.2 + .38a}$

If a be supposed equal to 48.56, or twice the angle of friction, the load would be 404 tons nearly, or one-third the load on a level.

On a grade of 30 feet the load would be 541 tons. The grade that would require double the power of a grade of 30 feet would be $84\frac{1}{2}$ feet.

If the gross load of a train on a grade of 30 feet be 541 tons, the engine and tender being 63 tons, the cars and contents will weigh 478 tons, or if 18,000 lbs. be allowed for each car and 22,000 lbs. for load, the number of cars will be 27 and the net load 297 tons, weight of cars 243 tons.

If the return cars shall be only one-fourth loaded, which is probably a full proportion for the Shenadoah Valley extension, the gross weight of the trains would be 380 tons.

The inclination that would employ the full power of the engine in hauling 380 tons, would be 53 feet.

The inclination that would employ the full power of an assistant engine in hauling a gross load of 380 tons, would be 130 feet, but allowance must be made for the weight of the assistant engine.

The following description of Indian sculpture on the banks of the Monongahela River, by Jos. D. Reid, was received through Prof. Cope, accompanied by a drawing of the same.

SKETCH AND DESCRIPTION OF A CARVED ROCK *on the bank of the Monongahela River, Pa.*, by JOSEPH D. REID.

(*Read before the American Philosophical Society*, Jan. 20, 1871.)

The engraving represents the face of a large rock lying on the east bluff of the Monongahela River, in Fayette County, Pennsylvania, opposite the village of Millsborough and the mouth of Ten Mile Creek.

Originally there were three rocks, but after the settlement of the country, two of them were broken up and used in building a mill dam. At that time no one valued or took any interest in them, so no record was kept other than the fact that they were larger, and the figures more numerous than on the one remaining. This is in its original position, partly buried in the earth and so worn by the elements that the figures have become indistinct, and some perhaps entirely obliterated.

The Indians that inhabited this part of the country at the time of its settlement by the whites, had no legend connected with the rock, nor had they used it for any purpose. The river bank at this point and for a mile above and below is nearly a perpendicular bluff, three hundred feet high, which is broken by a single ravine, and up this by a narrow winding path, apparently made by the same people that carved the figures on the rock, it may be reached directly from the river. A carriage road that leaves the river opposite Fredericktown, and winds around behind the bluff, passes within a few hundred yards of it.

The rock is sandstone, of the same formation as that overlying the coal bed below; the surface is nearly flat, of an area of twenty by twenty-four feet, with a depression diagonally across, in a line with the three cups or hollows, the largest of which is one foot in diameter, the middle one six inches, and the other three inches, and about the same in depth. The depression or gutter and cups, are discolored, apparently by the blood of the victims that the inhabitants offered as sacrifices to their deity.

The south end of the rock is three feet above the ground, with a hog-like figure carved upon it. The foot and hand prints are deeper and more perfect than the other figures, and in no way can I better describe them than they present the appearance of having been made by pressing the naked feet and hands upon soft clay, so perfect are some of the impressions. This is particularly the case with one foot-print, with a large toe on each side of the foot, and a hand-print with a thumb on both sides.

The largest impressions of feet measure fourteen inches in length, eight inches across the toes, and four inches across the heel, the other foot-prints vary in size from that of a full grown man to a child five years of age; the foot-prints of squirrels are numerous and cross the rock in every direction, not all that were on the rock being represented in the engraving. A single track of an animal with claws, and one intended to represent a buffalo track, but too small and no division of hoof, are also on the rock. The bird tracks are quite distinct and six inches in length; the three links have apparently been made recently. The other figures are outlines, and whether made as a pastime by some Indian artist or as the hieroglyphic history of an Indian race, I leave others to determine.

Two miles down the river from the rock is the site of an old Indian town and grave-yard, which covers an area of fifteen or twenty acres. There may be found pieces of sun dried pottery made of clay and minute fragments of muscle shells, pipes of the same material, and some of soap stone, axes of red ?jasper as hard as steel, arrow heads of flint, and circular flat sandstones, two of six inches in diameter and from one-fourth of

an inch to one inch in thickness, some of them with a hole in the centre and with a worn appearance of the edge.

The graves are covered with flat stones taken from the cliff above the town; they were placed about two feet below the surface, and being out of reach of the plow, the graves are seldom disturbed; one opened a few years since, exposed the skeleton of a female in a sitting position with a child in her arms, the skull of the child stuck to the stone, and when exposed to the air for a few minutes a slight puff of wind carried it away in a little cloud of dust. The skeletons are found in a sitting position facing the east and after being exposed a short time fall to dust. Nothing besides pieces of charcoal have been found in the graves with the bones. (See Plate I.)

The following members were nominated and elected to serve on the Standing Committees for the year:—

Finance.—Mr. Fraley, Mr. E. K. Price, Mr. Marsh.

Publication.—Prof. Trego, Mr. E. K. Price, Dr. Carson, Mr. Fraley, Mr. W. M. Tilghman.

Hall.—Gen. Tyndale, Mr. E. Hopper, Mr. S. W. Roberts.

Library.—Dr. Bell, Dr. Coates, Mr. E. K. Price, Dr. Carson, Dr. Krauth.

On motion of the Secretary, the reading of the list of members was postponed to the next stated meeting.

Pending nominations Nos. 661 to 668, and new nominations Nos. 669, 670, were read.

Balloting then proceeded; and there being no other business, the ballot-boxes were examined by the presiding officers, who declared the following named persons duly elected members of the Society:

M. Esquirox de Parieu, of France.
Mr. W. T. Roepper, of Bethlehem.
Rev. W. C. Cattell, of Easton, Pa., Pres. Lafayette Coll.
Mr. H. M. Phillips, of Philadelphia.
Mr. Thos. Meehan, of Germantown.
Gen. George G. Meade, of Philadelphia, U. S. A.
Lieut. C. E. Dutton, of Frankford, Pa.
Mr. Ed. Goodfellow, of Philadelphia, U. S. Coast Survey.

And the Society was adjourned.

Stated Meeting, February 3, 1871.

Present, twelve members.

MR. FRALEY, Vice President, in the Chair.

Mr. Goodfellow, a newly elected member, was presented to the presiding officer, and took his seat.

Letters accepting membership were received from Mr. W. Thos. Roepper, dated Bethlehem, Jan. 30; from C. E. Dutton, Lieut. of Ordnance U. S. A., Frankford Arsenal, Jan. 30; from Thos. Meehan, dated Germantown, Jan. 26; from W. C. Cattell, dated Lafayette College, Easton, Pa., Jan'y 23; from Edward Goodfellow, dated 927 Clinton Street, Phila., Jan'y 23; and from Geo. G. Meade, Maj. Gen. U. S. A., dated Phila., Jan'y 30, 1871.

A letter was received from Wm. Lowber, M. D., dated 319 S. 16th Street, Phila., Jan'y 8, 1871, offering for the acceptance of the Society the glass cylinder of the electrical machine belonging to his great-grandfather, David Rittenhouse, an early President of the Society. On motion, the offer was accepted, and the Curators were desired to return to Dr. Lowber the thanks of the Society.

A letter was received from Wm. Hitchman, M. D., dated 29 Erskine Street, Liverpool, Eng., January, respecting the organization of a Liverpool Anthropological Society.

Donations for the Library were received from the Italian Committee of Geology, the Academia dei Lincei at Rome, the Berlin Academy, the London Astronomical Society, the Essex Institute, the Boston Natural History Society, the American Journal of Science, the Franklin Institute, Penn Monthly, Pennsylvania Institution for the Blind, American Journal of Pharmacy, and London Nature.

The death of George Ticknor, of Boston, a member of the Society, Jan. 26th, aged 80 years, was announced by the Secretary.

On motion, Dr. H. Hartshorne was appointed to prepare an obituary notice of the late Dr. Rhoads.

On motion, Prof. Kendall was appointed to prepare an obituary notice of the late Prof. Chauvenet.

Mr. Cope reported that Mr. McNeil was prosecuting his researches in Panama, and had sent home fossils, showing among other things, that the back bone or water shed of the Isthmus was an ancient coral reef, many of the corals being in an excellently well preserved condition.

THE PORT KENNEDY BONE CAVERN.

Prof. Cope announced the discovery of a bone cave by Mr. Charles M. Wheatley, in the Calciferous limestone, at a point about 25 miles N. W. of Philadelphia.

There had been obtained numerous remains of plants, and insects, with about thirty species of *vertebrata*.

These consisted of Reptiles, Birds and Mammals. The first were serpents, and tortoises of several species, mostly harmless. The birds included a turkey and snipe. The mammalian remains were most numerous, embracing various forms.

There were *Rodentia*, of American types, as *Hesperomys*, *Fiber*, etc.; also *Sciurus*, *Lepus*, etc.

There were Ruminants, several tapirs, and a small horse. Two carnivoxes of large size, one a cat, the other a bear, *Ursus pristinus* of Leidy, of a remarkable type, and entirely distinct from the cave bear, or living species of Europe and America. Remains of several Sloths were discovered, which were mostly of gigantic size. These were referable to at least three species, one *Megalonyx wheatleyi* was new, and two *Mylodons*, one of them probably also new to science. With them occurred the teeth and tusks of the *Trilophodon ohioticus* (Mastodon). This animal had probably fallen in, as the cave was rather a fissure at the point examined.

The bones were not gnawed. The fissure was 40 feet deep, 15 feet in width, and of unknown length. Above the cave deposit, it was filled with wash from neighboring hills of Triassic age.

Mr. Lesley desired to place on record the recent exposure of a bed of solid brown hematite iron ore, at the upper limit of No. II, Lower Silurian Limestone Formation, in Leathercracker Cove, Morrison's Cove, Middle Pennsylvania, of very unusual size. The bed is nearly vertical and 72 feet thick, where cut across by a water drift. No such deposit has been before discovered at this horizon, in a situation favorable for exact measurement.

Pending nominations 669, 670 were read, and the reading of the list of members was postponed, and the Society was adjourned.

Stated Meeting, February 17, 1871.

Present, ten members.

MR. FRALEY, Vice President, in the Chair.

Mr. Carey accepted by letter, the appointment to prepare an obituary notice of Mr. Colwell.

Letters of acknowledgment were received from the New York, New Jersey, and Georgia Historical Societies (85); Cincinnati Observatory (85); Smithsonian Institution (84 and XIV. 2), and Reichenbach N. H. Society (78, 79, 80).

Donations for the Library were received from the Royal Academy and Observatory at Turin, Levant Herald at Constantinople, London Nature, Philadelphia Journal of Pharmacy, Medical News, McCalla & Stavely, the Librarian of Congress, and the Wisconsin State Historical Society.

No. 85 of the Proceedings, just published, was laid on the table.

The death of John F. James, a member of the Society, at Philadelphia, Feb'y 5, was announced by the Secretary.

Mr. Lesley asked for information respecting the alleged discovery of a hewn cave and crypt with hieroglyphics, skeletons, vases, &c., lately made by a railroad engineering party

in Iowa: and connected it with Baron Burck's account of the traditions he found among the Aztecs, of the migration of that race or tribe from the Northeast or Upper Mississippi and Missouri country.

Mr. Coxe described a locality at Baker's Run, on the West Branch of the Susquehanna, where the great freshets of 1863 uncovered ancient hearths and numerous large vases, all of which were soon broken and scattered by the curious.

The minutes of the last meeting of the Board of officers were read.

Dr. Emerson introduced the subject of Lunar Influence, or supposed influence, upon the conditions of wet or dry weather.

On Lunar Influence *upon the Conditions of Wet or Dry Weather*, by Dr. Emerson.

(*Read before the American Philosophical Society, February* 17, 1871.)

That the moon exerts such an influence, he said, is a very old opinion, widely spread at the present day, and even maintained by many distinguished philosophers. A great deal of attention has been devoted to tabulating atmospheric observations in relation to the conditions of the weather at the quarterly changes of the moon. The results of such laborious investigations have, however, not been found to agree, some reports seeming to favor the existence of lunar influence in producing wet and dry weather, and others, to show that no such influences are exerted by the moon upon the hygrometric conditions of our atmosphere. Among the many who have engaged in investigating this subject I will only refer to the celebrated Italian philosopher Toaldo, whose observations were extended through a period of forty-five years, and to Pilgram, whose observations were extended through a period of fifty-two years. For some reason which I shall not attempt to explain or examine, the conclusions of these indefatigable observers and inquirers *were the very opposite of each other*.

The circumstance which has perhaps contributed most to strengthen the belief in lunar influence upon the weather, is the well known agency exerted by the satelite upon the ocean and atmosphere, in the production of tides and barometrical fluctuations. Both of these phenomena are attributable to the force of *gravitation*, acting between the earth and moon, and giving rise to ocean and atmospheric waves.

The atmosphere surrounding our earth consists: first, of a mixture of permanently elastic gases; and secondly, of a changeable atmosphere of watery vapor, depending for its suspension entirely upon heat. This

theory of an independent atmosphere of vapor owing its suspension to heat alone, was established by Dalton, and is as incontestible as the theory of gravitation established by Newton.

When watery vapor suspended in the air loses the amount of heat necessary for its suspension, or, in other words, when the temperature is reduced to the "Dew-point," vapor is immediately condensed into mist, dew, clouds and rain. Now there is good reason to believe that the moon exerts no appreciable influence, directly or indirectly, upon the temperature of our atmosphere.

Some who have attempted to investigate this point by using reflectors and very delicate thermometers, have been led to the absurd conclusion that the moon's rays emitted cold. The marked depression observed in the thermometers exposed to the lunar rays, was in no wise produced by these, but by radiation of heat from the instruments into a clear sky.

In many parts of the surface of our globe, extensive regions exist in which it seldom or never rains, as in Lower Egypt. But in such places the atmosphere is very dry, and no local causes exist, such as mountains or hills, to interfere with the regular currents of the atmosphere and favor the mixture of strata of different temperatures. Consequently, rain rarely falls.

In other regions, in the Tropics, for example, there are extensive spaces in mid-ocean embracing many thousands of square miles, where the temperatures of the sea and atmosphere remain constantly within one or two degrees of each other, with the atmosphere of vapor close upon the "Dew-point." Here, if anywhere, the moon might be expected to produce changes in the hygrometric conditions of the atmosphere. But for months continued, there is no rain or other proof of lunar influence upon the weather. It is only in the extra-tropical latitudes where many other active agencies exist to disturb the equilibrium of atmospheric temperature, that the advocates of lunar influence assume to find evidence in favor of their views.

The power exercised by the moon upon bodies of water and permanent elastic gases on the surface of our planet, is solely derived from the law of *gravitation*, which exercises no influence, direct or indirect, in suspending or condensing vapor, or controlling the conditions of weather as to wet or dry. These conditions are brought about solely through changes of *temperature*, during the operations of which the moon remains a silent spectator, taking no active part, so far as the condensation of vapor is concerned.

Pending nominations 669, 670 were read.

On motion of Mr. Winsor, the Library Committee were instructed to report upon the subject of completing and publishing the Catalogue of the Society's books and pamphlets.

And the meeting was adjourned.

A CASE

OF UNIVERSAL HYPEROSTOSIS, ASSOCIATED WITH OSTEOPOROSIS, WITH A DESCRIPTION OF THE SPECIMENS, by J. Ewing Mears, M. D., W. W. Keen, M. D., Harrison Allen, M. D., and William Pepper, M. D.

(*Read before the American Philosophical Society, Dec.* 2, 1870.)

The undersigned, to whom were referred the above specimens, presented by a friend to Dr. J. Ewing Mears, have carefully examined them, and have prepared the following Report:—

In the investigation of the subject, we have prepared as full a history of the case as could be obtained, a detailed account of the general anatomical characters of the disease, and of the peculiarities of each individual bone, as well as of the microscopic appearances, have consulted the works and periodicals in various languages accessible in this city, and have examined all the specimens contained in the Museums of the College of Physicians, Academy of Natural Sciences, University of Pennsylvania, Jefferson Medical College, and also the hospital and private collections in the city.

We have nowhere found specimens of this disease, or descriptions of such, at all equalling in extent and severity these here described.

The only similar case, though far less in degree and extent (skeleton imperfect), is found in Virchow's Archives, Vol. 43, 1868, p. 470, plate No. 12, although we have met with specimens and descriptions of skulls and bones which afford evidences of a limited development of the same disease.

Of the pathology of the disease, as well as of the anatomical appearances (116), we have found the best descriptions in Lobstein, Traité d'anatomie pathologique, Tom. II, p. 116; Boyer, Sur les Maladies, Chirurgicales, Tom. III, p. 571; Paget, Surg. Path. Eng. Ed., pp. 301–2, and fig. 40; Stanley on the Bones; S. Solly, Med.-Chir. Trans., Vol. 27; Förster Handbuch der Path. Anat., Bd. I, S. 249–52, and Bd. II, S. 850–4; R. Volkmann, in Pitha und Billroth's Handb. der Chirurgie, Bd. II, S. 249–58; Oeffinger, Virchow's Archiv, Bd. 43, S. 470; Haubner, Canstatt's Jahresbericht, 1854, Bd. 27, S. 23–4; Virchow, Die Krankhaften Geschwülste, Bd. II, Vorlesung XVII.

HISTORY OF THE CASE.

Fully recognizing the importance the history of the case has in the discussion of the Etiology and Pathology of the disease, we regret our inability to add any information to the statement given at the time of the presentation of the specimens, which is as follows:—

A. M. aet, 14, native of England—occupation farm boy—came from England to this country when very young—father died in November, 1862, of Phthisis, aged 57—mother died in 1867, cause of death not ascertained—has one brother and one sister, both young and healthy. In September, 1866, while engaged at work on the farm, noticed swelling

beginning in the face, and also, that in stooping, face felt puckered and wrinkled, while the effort to regain the erect position gave intense pain along the entire spinal column. Subsequently the fore-arms became sore and swollen, was placed under treatment, which was of such decided benefit that he thought himself entirely well, and in March, 1867, resumed his farm duties; about two months later the symptoms returned in an aggravated degree, the feet and then, in succession, the legs and thighs becoming enlarged and very painful; under the influence of constant bandaging the swelling diminished; his appetite became impaired, and he died from exhaustion Feb'y 8th, 1868. The treatment adopted was mostly of a tonic character.

DESCRIPTION OF THE SPECIMEN

(See Plates I. and II.)

I. WHAT BONES ARE WANTING.

We have the entire skeleton except the following bones:

Vertebræ—5th and 7th cervical.
1st and 10th dorsal.
2d lumbar.
2d and 4th sacral.
all the coceygeal.
Sternum, gladiolus and ensiform.
Hyoid bone.
Right Patella.
Hands, all wanting save the right scaphoid.
Feet, all wanting save left calcis.

Five metacarpal and metatarsal bones and eight phalanges are preserved, but, except the two metatarsals of the great toe, they can scarcely be designated, they are so greatly deformed.

II. THEIR CONDITION.

Unfortunately, by the prolonged boiling to which they were subjected before coming into our possession, the bones have lost probably all their animal matter, and are now almost as friable as if they had been burned. By removing the marrow, also, this has rendered the pathology of the disease much less clear and the microscopic examination much less valuable than it would otherwise have been. Moreover, it has removed probably all the gelatine, so that the chemical examination and the specific gravity would be worthless. Even the weights are, by reason of this misfortune, only of slight value. All the epiphyses too, except the coracoid process of the scapula, are separated from the shafts or bodies, and in some bones even integral parts are separated, *e. g.* the sacrum is divided into its component vertebræ and the innominate bone into two pieces. Many of the epiphyses are preserved, as will be indicated in describing each bone. The epiphyses have attached to them in many places the dried gelatinous articular cartilages of a transparent

brown color, and when an epiphysis has been incompletely ossified, the cartilaginous portion presents itself as a similar dried gelatinous mass. The ends of the shafts of the long bones are very ragged also, the cancellated substance being exposed and more or less broken.

III. WEIGHTS AND MEASUREMENTS.

In order to have some relative standard of weight, we have also weighed the bones of a girl of about seventeen. But, it must be observed, that all these but the scapula (which wanted the acromion epiphysis) were weighed with all the epiphyses. These healthy bones were rather slender, but were also longer than the diseased bones (the diseased and healthy femurs being 14½ and 16 inches respectively, excluding the lower epiphyses).

Diseased Bones.		*Healthy Bones.*	
Femur (without lower epiphysis)	8 oz.	Do (with all epiphyses)	8 oz. 3½ drms.
Tibia (" " ")	5½ "	Do " "	5 " 1½ "
Humerus (with all epiphyses)	3½ "	Do " "	2 " 3½ "
Radius (without epiphyses)	1½ "	Do " "	6 "
Ulna (without lower epiphysis)	2 "	Do " "	6½ "
Clavicle (" inner ")	½ "		
Scapula (" all epiphyses except coracoid)	1 "		
Fibula (without both epiphyses)	1½ "	Do " "	7½ "

The following are the measurements in circumference of the bones, the same healthy skeleton as before being used for comparison.

	Diseased Bones.	*Healthy Bones.*
Femur (middle),	5 in.	2⅜ in.
Tibia "	4¾ "	2½ "
(at tubercle),	5⅝ "	4⅞ "
Humerus (middle),	4¼ "	2 "
(above condyles),	5 "	3¼ "
Radius (middle),	3½ "	1¼ "
(lower fourth),	4¼ "	1⅞ "
Ulna (" and middle),	3½ "	1½ "
(just below corocoid),	4⅛ "	1⅝ "
Fibula (lower fourth),	1¼ "	1⅜ "
Clavicle (acromial extremity),	3¼ "	2⅜ "

The following are the diameters. In general the original limits of the bone were pretty easily distinguished. The external line of demarcation in the femur and the posterior in the tibia are so indistinct that the diameters of the original bones are not wholly reliable. All the diameters are derived from longitudinal sections by a circular saw, and they are all at the middle unle s otherwise stated.

	Original Bone.	*Diseased Bone.*	*Addition by Disease.*
Femur,	1 in.	$1\frac{1}{2}$ in.	$\frac{1}{2}$ in.
Tibia,	1 "	$1\frac{9}{16}$ "	$\frac{9}{16}$ "
Humerus,	$\frac{7}{8}$ "	$1\frac{1}{8}$ "	$\frac{2}{8}$ "
Radius (middle),	$\frac{7}{16}$ "	$1\frac{1}{16}$ "	$\frac{5}{8}$ "
(upper third),	$\frac{1}{2}$ "	$\frac{7}{8}$ "	$\frac{3}{8}$ "
(lower third),	$\frac{7}{4}$ "	$1\frac{1}{4}$ "	$\frac{1}{2}$ "
Ulna (middle),	$\frac{7}{16}$ "	1 "	$\frac{9}{16}$ "
(at coronoid),	$\frac{5}{8}$ "	$1\frac{1}{4}$ "	$\frac{5}{8}$ "
(lower third),	$\frac{3}{8}$ "	1 "	$\frac{5}{8}$ "
Metacarpal (great toe),	$\frac{1}{2}$ "	$\frac{11}{16}$ "	$\frac{3}{16}$ "
Phalanx "	$\frac{7}{16}$ "	$\frac{11}{16}$ "	$\frac{1}{4}$ "
Clavicle,	$\frac{3}{8}$ "	$\frac{7}{4}$ "	$\frac{3}{8}$ "
Fibula (upper & lower thirds)	$\frac{5}{16}$ "	$\frac{7}{4}$ "	$\frac{7}{16}$ "
Ilium (1 in. above acetabulum),	$\frac{9}{16}$ "	$\frac{7}{8}$ "	$\frac{5}{16}$ "

IV. General Description.

The bones which have suffered the most are the clavicle, humerus, radius, ulna, femur, tibia, fibula, metacarpals, or-tarsals and phalanges of both hand and foot. These are diseased in almost the entire length of their shafts. The radius and ulna have suffered rather more than any of the other bones just named. All the other bones of the trunk have suffered to some extent, those of the skull but very little or not at all.

Comparing the upper and the lower extremities, there is no appreciable difference in the violence of the disease.

Comparing the two sides externally, not only is there no difference in the extent and character of the disease, but there is the most remarkable symmetry of the corresponding, diseased bones, which may be traced even to details. (Figs. 9 and 10.) The disease begins and ends on both sides at corresponding points, it changes in character from simple porosity to the growth of osteophytes at corresponding points; if on one side the posterior part of the bone is most diseased, the same is true of the other side; if the osteophyte growth is continuous or interrupted on one bone (fibula Fig. 18) it is so on the opposite one; if one is unusually diseased at a tendinous or aponeurotic insertion, so is its mate; if a groove or a variation in color exist on the one side, the same will be found on the other side; even of single marked spiculæ of bone the same may be said; so that a description of one side will answer for both, minute differences being noted as they occur.

The main violence of the disease is expended on the shafts of the long bones. The epiphyses, of which the most important remain, *e. g.* those of the femur, tibia, humerus, &c., show we may almost say no disease. The lower epiphysis of the femur is slightly porous in the usually compact layer of the articular surface, but so fine is the porosity and so slight the disease that it would not be observed save on a most careful examination.

The other epiphyses show occasionally still slighter disease. Indeed it is a question whether this be not the result of the prolonged boiling. The bones of the trunk are but little affected except the sternum, which must have suffered severely, the manubrium being very porous and much thickened. The bones of the head are scarcely at all affected.

The point of greatest development of the disease varies with its character. 1°. The thickening is most developed in the middle of the shafts, and here generally the sclerosis is furthest advanced. (Figs. 3, 4, 5, 21.) 2°. The porosity is not noticeably greater in any particular parts of the shafts, but seems externally to be equally diffused. 3°. The osteophytes follow a marked law in their development. They are most developed where the muscles, aponeuroses, fasciae, &c., are attached, *e. g.* the linea aspera, interosseus ridges of the tibia and fibula, radius and ulna, the insertion of the deltoid, biceps and brachialis anticus, the condyloid ridges of the humerus. But it is not always true conversely, that where a large muscle is attached there must be a large osteophyte growth, *e. g.* there are none at the origins of the pectoralis major and sterno-mastoid, the supra- and infra-spinatus, the insertion of the quadratus femoris, &c. One class of exceptions is, however, to be noted, viz: that at the attachment of those muscles and ligaments that are connected to epiphyses, there is generally no disease, *e. g.* the muscular attachments to the greater and lesser trochanters, the greater and lesser tuberosities, tubercle of the tibia, the tuber ischii and nearly all the ligaments. The epiphyses and their attached parts are very nearly all quite free from disease, though it may be largely developed in their immediate neighborhood.

The direction of the nutritious artery seems to have had no influence on the development of the disease either in its extent or degree.

The porosity varies in its character, and usually any one bone will show all its varieties. 1°. The surface of the bone presents a very fine cribriform appearance, resembling pumice stone. When magnified six or eight times this is seen to consist of a stout network of bone perforated by numerous small foramina, which are generally tolerably circular, and do not communicate one with another. (Fig. 24.) 2°. It may be of a finer velvety appearance. This by the same power is seen to consist of the same network of bone, whose very large foramina or meshes now communicate and are therefore very irregular in form, while the ridges forming the bony net-work are very thin and form relatively high walls between the adjacent meshes. Sometimes these ridges assume a tolerably regular parallelism, giving a striated appearance to the part. 3°. A coarser appearance is often produced by a similar honey-combing with large foramina or meshes, deep and irregular, varying in size from a horse-hair to a line in diameter with the first or second variety existing in the intervening ridges. (See lower end of Humerus, Fig. 1.) 4°. The surface is often pierced more or less sparsely by small foramina about the size of a horse-hair. (Fig. 20.)

The osteophytes vary greatly also in their character. In shape they

are either pointed, flat, or clubbed, sessile or pedunculated. They frequently form larger or smaller scales, which cover more or less of the bone. They vary from the smallest size visible up to $\frac{3}{4}$ inch in length or $\frac{1}{2}$ inch square. They are often compound, smaller ones growing from larger ones as a base. Imbrication is not unusually a marked feature, and whether imbricated or not, their direction or "trend" almost always follows that of the fibres attached at that point. This is very marked where adjacent muscles run in different directions, *e. g.* the flexor attachments of the radius and ulna as contrasted with that of the pronater quadratus. (Figs. 11 and 15.) The grooves between the osteophytes have sometimes rolling edges, sometimes are as sharp as if cut with a knife, and often lie closely together and parallel; they are apparently made in many cases by the numerous small vessels. All of the osteophytes are more or less porous.

The color is usually normal, but in some places is of varying shades of brown.

On a section the whole bone is seen to be encased with a new formation of bone. This is true not only of the long bones but also of the scapulæ and ossa innominata. Viewing these bones and also many parts of the shafts of the long bones on the surface, one would suppose he had simply to do with the original thickened bone which had undergone this porous change. But a section shows that there is a complete new formation which is added layer after layer around the old bone. These layers (excepting where sclerosis has taken place) are separated by interspaces sometimes just appreciable to the eye, sometimes a quarter of an inch wide. (Fig.17). The outer layer is often very thin, but presents to the eye that deceptive appearance of apparent compact tissue which has simply become porous. Where sclerosis has taken place or osteophytes are developed, of course the thickness of the outer layer is either greatly increased or else undeterminable. The other layers also vary in thickness from the development of the sclerosis from the thinnest possible to one or two lines. "These layers may sometimes be traced into continuity with those forming the healthy portion of the wall"* of the original bone, especially at the extremities of the shaft. (Fig. 4.) At these points, starting from the original compact tissue, the several layers of the encasing new formation gradually become more and more widely separated or new layers may appear, thus producing a very great thickening at the centre, while at the ends of the shaft the thickening gradually (sometimes suddenly) diminishes. The interspaces between the layers are sometimes for even an inch wholly void, but they are generally filled with intervening trabeculæ of bone, which form a cancellated tissue and also support the superimposed layer to which they are always *perpendicular*. To a very large extent these layers have been welded together by sclerosis, and sometimes the new growth and the original bone present no line of demarcation by which they can be distinguished. Where this solidification has taken place, the cut surface instead of the uniform ivory-like solidity of normal compact

* Paget. Surg. Path. Eng. Ed. 1863, p. 301-2, and fig. 40.

tissue presents a granular appearance, as if the cancelli of the interspaces were not solidly filled up. The process of sclerosis not infrequently dips down like a cone whose base is of considerable extent at the surface of the new growth and whose apex just touches, or is sometimes welded with the original compact tissue. (Fig. 21.) Eburnation has nowhere taken place.

The original bone, too, has undergone marked changes. Its limits are generally pretty well defined, but the compact tissue of which its wall once consisted, is now cancellated, to a greater or less degree (osteo-spongiosis). Sometimes all appearance of compact tissue, save a mere worm-eaten porous external film, has disappeared. Sometimes no cancellation appears, but the old and new growths are welded together. The cancelli of the once compact tissue of the old bone always run *parallel* with the *axis* of the bone, and are thus easily distinguished from those of the spaces between the laminæ of the new growth which run at *right angles* to the surface of the bone. (Figs. 4 and 17.) The old cancellated tissue has often very large cancelli and in some cases has disappeared, leaving a wider medullary canal than is normal.

The epiphyses do not appear materially altered on section.

V. Description of Individual Bones.

1. *Head.*—All the bones of the head are present, completely disarticulated. The spheno-occipital suture was not ossified. No sections were made of these bones, and the external appearances alone are described.

(a) Frontal. The roof of the orbit, especially in the fossæ for the lachrymal glands, is somewhat porous. Internally the porosity appears over various parts of the perpendicular portion. The irregular striated appearance from large numbers of fine grooves is marked, and sclerosis seems to have made considerable progress.

(b) Parietal. Externally slightly porous at the posterior border; internally also over, say one-fifth of the surface, corresponding to the protuberance.

(c) Occipital. Externally small scattered patches of porosity; internally the same change is limited to the superior fossæ and the groove for the left lateral sinus.

(d) Sphenoid. Porosity of external surface of greater wings, and also in most of the pterygoid plates, which are somewhat thickened.

(e) Temporal. Slightly porous and thickened externally on squamous portion, and in the glenoid cavity and in the grooves for both lateral sinuses.

(f) Sup. Max. Slightly porous on anterior surface, and at the tuberosity. The alveoli are reticulated so as to resemble almost the meshes of the pulmonary structure.

(g) Palate. Internally, slight porosity at the junction of the perpendicular and horizontal portions.

(h) Inf. Max. Ascending ramus markedly thickened, and porous internally and externally; most developed at the centre of the ramus;

body similarly affected, principally between the mental foramen and the external oblique line. Alveoli like those of the upper jaw. This bone has suffered more than any other bone of the skull.

Condition of Teeth.—The teeth were all present, and were carefully examined. They were very brittle, so as to break across with little difficulty (see *Micros. Ex.*), but presented no peculiarity of shape. The entire absence of the peculiar deformity of the incisors, noted by Hutchinson, of London, as characteristic of hereditary syphilis, is to be especially marked as it bears upon the question of causation of the morbid process.

2. *Vertebræ.*—The epiphysal plates of the bodies, and the epiphyses of the transverse and spinous processes, are all gone. In the dorsal region the groove between the three original parts in which the ossification takes place, is very deep, but they are all united more or less. This groove gradually disappears both above and below, none of the remaining cervical vertebræ showing it, while inferiorily it is visible as far as the first sacral. On section the body is not much thickened, and no line of demarcation exists. No sclerosis has taken place.

(a) Cervical. Scarcely noticeable porosity of the anterior surface of body. Posterior arch of atlas is unusually thick and dense.

(b) Dorsal. Marked porosity of external surface of body, which is elevated above the surface left by the removal of the slightly overlapping epiphysal plates, about one-half a line to a line. Spinous processes slightly porous.

(c) Lumbar and Sacral. Same as dorsal; the porosity of spinous processes being more marked.

3. *Sternum and Ribs.*—(a) The manubrium only is present, and is very thick and porous. No osteophytes.

(b) The ribs have lost all their epiphyses. They are not affected on the external surface, save slightly in one or two instances. On the pleural surface they are all porous, and often a little thickened. For about one inch from the head the entire bone is thickened and porous.

4. *Upper Extremities.*—(a) Clavicle. The sternal epiphysis is wanting. Where the surface for the articulation with the acromion should be, there is on each side an oval cup-like depression $\frac{1}{2} \times \frac{1}{4}$ in. and $\frac{1}{8}$ in. deep. (Fig. 13.) Its walls are perpendicular, its floor flat, and both are covered with a thin layer of compact tissue resembling that which covers all the ends of the diaphyses of the other bones next the epiphysal cartilage. It was filled, when first seen, with a small mass of dried tissue resembling the epiphysal cartilage already described. Possibly it may have been an unusual third centre of ossification for this bone. It was occupied, certainly, by some substance separate from the shaft of the clavicle, either a third centre of ossification, or a projecting piece of the acromion. If the former, it is a very unusual place for a supernumerary epiphysis.

The whole bone is thickened to about twice its normal width, and its surface is coarsely porous throughout. At the insertion of the ligaments on the under surface, the porosity is quite fine and velvety. At the inner half of the origin of the deltoid there are twelve to twenty stout and well

developed osteophytes. A few also exist at the middle of the insertion of the trapezius. The section shows the original bone distinct from the new growth at all points. The laminæ of the new growth are very distinct at most points. A large part of those of the under surface are more or less closely united by partial sclerosis. The original bony tissue is relatively but little altered.

(b) Scapula. The coracoid process is one-third united to the bone, but wants the epiphysis developed on it at about seventeen years of age. All the other epiphyses are absent.

The bone is porous throughout, save at the centre of the infra-spinous fossa; generally of the coarse variety, but very fine in certain spots. The whole bone is somewhat thickened, as can be seen without any section, at its posterior border and on the spine. (Fig. 23.) The latter being to a great extent denuded of the outermost compact, yet porous layer of the new growth, shows the reticulated trabeculæ which supported it, and through their meshes the old external compact layer of the original bone now all worm eaten and very thin. This is especially well seen at the two extremities of the spine. The axillary border of the bone is three or four times as thick as is normal, has a few coarse osteophytes, and a very deep and wide groove for the dorsalis scapulæ artery.

(c) Humerus. All the epiphyses are preserved except that of the internal condyle. The trochlear surface projects only to a level with the radial.

The whole shaft (Figs. 1 and 2) is involved in the disease, the least at the upper fourth, the other three-fourths being about alike. The porosity is almost wholly very fine or velvety. About two inches below the head, at the insertion of the Pect. maj., the anterior bicipital ridge is greatly thickened (especially on the right side). It is continuous with a very large elevated surface ($2 \times 1\frac{1}{2}$ in.) at the insertion of the deltoid. This is covered with a large mass of not very large porous osteophytes whose trend is generally upwards. One (r. side) or two (left) large flat imbricated osteophytes mark the posterior lip of the bicipital groove. At the musculo-spiral groove, which is well marked, the bone is finely porous, but presents no osteophytes. At the lower third, anteriorly, the bone presents numerous osteophytes, sometimes single, but generally in groups. They are sessile, porous, and in some cases imbricated; their trend is generally downwards, except just above the epiphysis, where they are at right angles to the bone. The two condyloid ridges, especially the inner, are greatly diseased. The external ridge (especially on the right side) has several large porous sessile outgrowths with intervening grooves, the largest groove about corresponding in position to the anastomotica magna artery. The internal ridge up to the insertion of the coraco-brachialis is covered with large knobby and porous, imbricated osteophytes, continuous with a similar remarkable growth on the posterior surface of the bone, covering the origin of the internal head of the triceps, which extends to the musculo-spiral groove above, and fades into simple porosity externally. At the origin of the external head of the triceps, there is also a

marked elevation covered with pointed osteophytes, and continuous with that of the deltoid insertion. The trend of all these osteophytes is downwards, and their color (especially on the right side) is a light brown.

The section (Figs. 3 and 4) shows the outline of the old bone obliterated in the lower third, and only faintly visible in the upper two-thirds anteriorly. In the posterior upper two-thirds the laminæ of the new growth are admirably shown, though even here the sclerosis is in some parts far advanced. The original compact wall in the superior one-third, anteriorily, and two-thirds posteriorly, has almost disappeared, the cancellation (spongiosis) is so great, and it is a typical illustration of this process in various stages. The original cancellated structure is either fragmentary, its cancelli being very large, or else it has entirely vanished, leaving an enlarged medullary canal.

(d) Radius (Figs. 9, 10 and 11.) All the epiphyses are gone, save the left upper one. Instead of being rounded externally, and showing a sharp interosseous ridge internally, it is almost cylindrical, increasing in diameter from above downwards. At the bicipital tubercle there is a crest of curved osteophytes under which, as in a cave, the tendon of the biceps was inserted. The oblique line is marked by a series of knobby, porous, slightly imbricated osteophytes, whose trend is downwards and inwards till they reach the insertion of the pronator teres, where their size increases, and their trend is upwards and outwards. The interosseous border is rounded off and marked by a series of deeply imbricated laminated osteophytes, all trending downwards, resembling a rounded surface deeply grooved by oblique parallel cuts of a thin saw. Where the pronater quadratus was attached, a large number of osteophytes exist in ridges, which run latterally. All the rest of the bone is thickened and porous, and where the muscles took origin, is covered with porous osteophytes.

In section (Fig. 8) the outlines of the original bone are visible throughout; the laminæ of the new growth are marked; the sclorosis is in various stages, and anteriorly for some two inches the new and old growths are almost welded together. The old compact tissue is wholly changed to spongy, and the medullary canal is increased in size.

(e) Ulna (Figs. 14 and 15.) The lower epiyhyses are absent. Like the radius, the ulna is involved in its whole length, and is about twice its normal diameter. At the insertion of the brachialis anticus, a cup-like depression surrounded by an elevated ridge of osteophytes, exists, somewhat similar to that on the bicipital tubercle of the radius. The anterior surface is covered with small porous osteophytes, with a slight downward imbrication. At the attachment of the pronater quadratus they become more marked in their development, and the imbrication is external. The interossecus ridge is rounded off and marked, as in the radius, but with several unusually large and deeply imbricated osteophytes with a deep groove, probably that of the interosseous artery. Externally a brown discoloration is seen, which is the most noticeable on the right side. Posteriorly the bone is coarsely

porous, but very few osteophytes exist, save on the lower third. The intervening grooves run transversely, but are neither deeply nor sharply cut.

On section (Figs. 16 and 17) the line of the original bone can be distinguished throughout; the laminæ of the new growth are very marked; the sclorosis has welded together all the new layers anteriorly, and at the junction of the upper and middle thirds, the new and old growths are almost melted together both anteriorly and posteriorly. The interspace between the old bone and the first new lamina reaches one-fourth of an inch in width just below the olecranum, and the distinction between the perpendicular trabeculæ filling it up, and the longitudinal cancelli of the once compact tissue of the old bone is very marked. The medullary canal is scarcely, if at all, enlarged, and, indeed, at the point of greatest sclerosis above named, the same process seems to have invaded the canal itself.

5. *Lower Extremities.*—(a) Innominate Bones. The ilium is separated from the ischium and pubes, which are firmly and indistinguishably united together at their rami, but at the acetabulum are distinct. The Y-shaped piece uniting them is preserved, and is loose on both sides. All the other epiphyses are missing. The bones are porous throughout but not to a marked degree. The thickening varies from $\frac{1}{8}$ to $\frac{3}{8}$ of an inch, being greatest just above the acetabulum. On the ischium and pubes no osteophytes exist, save one small lamina on the body of the right pubes. The ilium is free from them except above the acetabulum for a considerable space, on and around the reflected origin of the rectus, where large and strong osteophytes exist, with a trend inwards and upwards.

On section of the ilium, (Fig. 12) the external surfaces, which otherwise would be thought to be the porous surface of the original bone, are seen to be the outer layer of the new growth. The original compact tissue has undergone spongiosis to a great extent. Sclerosis is furthest advanced just above the acetabulum.

(b) Femur (Figs. 6 and 7). All the epiphyses are separated. Both heads and great trochanters and the left lower epiphysis are preserved. The latter shows some very slight porosity, as already noticed.

Anteriorly the inter-trochanteric line is marked by a well developed growth of short, thick, rather acuminate osteophytes, separated by grooves running in the axis of the neck. A similar line of more slender imbricated osteophytes runs parallel to the base of the great trochanter and trends toward it. These two lines form the letter A. Immediately within this letter A (especially on the left side) the trend of all the osteophytes turns sharply downwards and so continues to the lower $\frac{1}{4}$ of the bone, where they are perpendicular. They are not very marked in their development. Just above the end of the shaft, however, they form an overlapping sheath to the bone. In the middle of the right femur an aperture ($1\frac{1}{4} \times \frac{3}{8}$ inches) exists in the ensheating new growth, disclosing

to view the original but altered bone. Posteriorly the osteophyte growth extends from half an inch below the lesser trochanter to within 2½ inches of the end of the shaft, and the same sheath-like appearance is very noticeable at its two extremities. Where not covered with osteophytes, the shaft is very finely porous and thickened. All the central two-thirds of the shaft is one vast mass of large, irregular, porous osteophytes. Their direction is not constant, but is in general downwards, and their shapes are very varied. The mass extends for about eight inches, along what was the tolerably sharp linea aspera, but is now about ¾ in. wide and about ⅜ inch thick. The posterior inter-trochanteric line and great trochanter are not affected, except a slight porosity in the former. The lesser trochanter is wanting, but for ½ in. around it there is no disease beyond some porosity save one squamous osteophyte on the right side.

On section (Fig. 5) in the axis of the head and great trochanter the outline of the old bone is not to be made out save internally, and then only imperfectly. The old and new growths are almost everywhere indistinguishably welded together. The laminæ of the new growth, too, are welded together save at a very few points. The old compact wall is still solid, but it looks granular and does not present the ivory-like solidity of normal compact tissue. The medullary canal is somewhat enlarged at the expense of its walls. At the lower extremity the trabeculæ of the cancellated substance are normal, but in the head and neck the arches for mechanical support are much less distinctly marked than is usual.

(c) Patella. The right patella is missing. The anterior surface of the left shows a few osteophytes trending downwards.

(d) Tibia. Both the upper epiphyses are preserved. The whole bone is greatly diseased and thickened to about twice its usual diameter. The tubercle is slightly thickened and presents a ragged edge above for articulation with the epiphyses, but the greater part of the tubercle being developed from the epiphyses the disease is not very marked. The crest is rounded in its whole length and porous. The internal sub-cutaneous surface presents marked swelling and porosity. There is but little osteophyte growth, and it is generally in the laminæ except at the sartorius insertion, where it is more developed. A number of deep grooves exist, generally longitudinal in their direction and most marked at the upper third. The posterior and external surfaces are covered with a warty growth of porous osteophytes which attain their greatest development at the interosseous border and especially at the oblique line. The general trend of all this growth is downwards. Grooves for the vessels are frequent and tolerably deep.

On section (antero-posterior) the outline of the old bone is distinct at the extremities, but in the central two-thirds it is barely visible in front and wholly lost behind, the sclerosis at this part having welded together all the laminæ of the new growth and the original bone. Even at the extremities the new laminæ are not very marked. The rarefaction of the original compact substance is of course therefore not marked. The medullary canal if at all altered is narrowed by the encroaching sclerosis.

(e) Fibula (Fig. 18). Its shaft alone is preserved, and its axis is slightly bent inwards. The whole bone is encased in a newly formed osseous growth which is sometimes simply porous, and is covered with sometimes an interrupted, sometimes a continuous, growth of warty osteophytes, all more or less porous. Posteriorly and internally this growth is most developed, the trend being downwards. The lower subcutaneous surface is greatly thickened and finely porous, but has no osteophytes.

On section the bone is doubled in its diameter, the outline of the original bone being only visible in about one-half of its extent, the sclerosis obscuring it at other points. The original compact tissue is rarefied by spongiosis, and the medullary canal is somewhat widened.

(f) Hand and Foot. They are considered together, as some of the bones are indistinguishable, and moreover, in general the same description applies to both.

(1.) Right scaphoid of hand. Not diseased.

(2.) Left calcis. Porous and enlarged throughout. Porous osteophytes are seen at the attachments of the tendinous sheaths internally, and one large flat one on the inferior surface. The epiphysis for the attachment of the tendo achillis is preserved, but shows no disease.

(3.) Metacarpus, metatarsus and phalanges. Two of the phalanges have their epiphyses attached but not united by ossification. The epiphyses are not diseased. No other epiphyses are preserved. All these bones suffer by far to the greatest extent in the centre, not at all at the head (viewed externally), and but little at the base, and the new growth is five or six times as thick on the dorsum as on the opposite surface. No osteophytes exist save on one of the metatarsal bones and at the ridges for the flexor sheaths of three of the phalanges.

On section (Fig. 21), compare also Fig. 22, the outlines of the old bones are very readily seen, the apex of the conical sclerosis having, at points, just touched the surface of the old bone. The original wall of compact tissue is wholly rarefied by spongiosis, and the cancelli of the new and old bone are readily distinguished by the different directions of their axes. The normal compact wall of the phalanges being very thick relatively, the changes in it are the more marked. Sclerosis has invaded from half to two-thirds of the new growth. The head of the bone is also markedly rarefied by spongiosis.

MICROSCOPIC EXAMINATION.

The specimens from which the following description and wood-cuts were made, were prepared with his well known skill by Dr. J. H. McQuillen. They consisted of a transverse section through the thickened wall of a phalanx, embracing the thickness of the layers superimposed by the periosteum, but not of the entire original compact layer of the bone, and of a transverse section through the right canine tooth.

The section of the phalanx (Fig. A) exhibited a quite compact osseous structure—the Haversian canals being for the most part round, and rather small, though in some places they were irregularly shaped or oval, and larger. The intervening bone lamellæ were of unusual thickness,

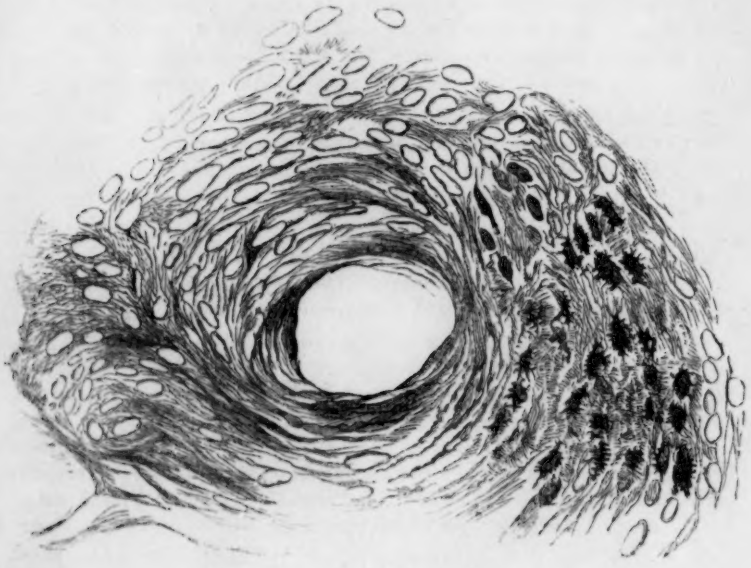


Fig. A.

and presented in the majority of cases, bone corpuscles with canaliculi. In some cases, however, no bone corpuscles were present, and the lamellæ appeared to be merely calcified by saturation with bone salts.

The bone corpuscles were small and often indistinct; in some places they were unusually round, but in others they presented the normal elongated shape; their canaliculi were invariably very poorly developed, and often could not be discovered.

With regard to the mode of arrangement of the bone lamellæ, they were always developed concentrically with (parallel to the walls of) the Haversian canals, and in no instance were any lamellæ found whose direction was parallel to the external surface of the shaft.

The section of the tooth (Fig. B) showed the existence of numerous irregularly shaped, branching lacunæ in the dentine near the marginal layer of enamel. These spaces were of various sizes and intercepted the

FIG. B.

course of a varying number of dental tubuli. They indicated unquestionably either an arrest of the process of calcification of the dentine, or of the resorption of calcareous matter already deposited, conditions which are also present in the true bony tissue. They are identical with the so-called *interglobular spaces* first described by Kölliker and carefully studied by Dr. McQuillen of this city, who has published (Dental Cosmos, N. S. Vol. VIII, No. 3, pg. 113,) several excellent illustrations of them.

PATHOLOGY OF THE DISEASE.

Having thus described the gross and minute features of these bones, we would hazard the following remarks in regard to the nature and cause of the pathological process :—

In the first place it is to be observed that three separate processes, or at least three distinct stages of the same process, are represented in different parts of the skeleton, or even, in some instances, in single bones. These stages are :

First. Internal Osteoporosis of the original osseous tissue. 2d. External Hyperostosis, due to successive attacks of Periostitis, both of which processes are present in varying proportion in almost all the bones, and 3d. Secondary Induration.

1. It is especially in regard to the explanation of the internal osteoporosis, which constitutes so marked a feature of these specimens, that we regret the absence of any careful examination of the bones in their recent condition. In their present state, it is only possible to describe the degree to which this rarefaction of the osseous tissue has occurred, but it is evident that such changes might be produced by very varied alterations of the medulla and bone corpuscles. Thus, among the recognized causes of osteoporosis, may be mentioned syphilis, scrofula, rheumatism; and, in addition, we must add that both osteomalacia and simple ostitis produce changes in the bones which, after the specimen has been boiled, and the organic matter entirely removed, are not to be distinguished from the effects of the first mentioned diseases. In each case, under the action of the morbid irritant, whether purely external and local, or internal and constitutional, there is more or less rapid proliferation of the essential vital elements of the osseous tissue, called bone corpuscles or cells. At the same time, the bony laminæ surrounding the Haversian canals, and the walls of the lacunæ, are progressively deprived of their calcareous salts and removed, while the enlarged spaces thus produced are filled by the constantly growing cellular elements. The manner in which this removal of the calcareous salts is effected has been, and indeed remains, a subject of much discussion. The first idea which seems to have been entertained may be inferred from the name, eccentric atrophy, which was given to many specimens of osteoporosis, under the belief that the bony lamellæ were thinned and pushed asunder by the centrifugal pressure of the growing medulla. There is, however, no evidence whatever in favor of such a mechanical explanation, and this hypothesis has justly been almost universally abandoned.

By far the most plausible explanation which has been advanced appears to be that the removal of the calcareous salts, the first essential step in the destruction of the bony lamellæ, is due to the solvent action of some acid elaborated by the bone cells during the inflammatory process. According to Weber, their removal is not due to the direct action of any acid, but is owing to a gradual conversion of the insoluble *tri-basic* phosphate of lime into the more soluble *bi-basic* salt.

As this feature of rarefaction is, however, common to so many diseases of the bones, it is evident that the most characteristic results of such diseases are to be rather found in the condition of the bone cells, and in the characters of the morbid product which has resulted from their multiplication. And it is to be trusted, that by careful chemical and microscopical study of these, such peculiarities will be discovered as will enable us to distinguish with certainty in recent bones the various morbid changes.

Heretofore the majority of observers have limited themselves either to a description of the dried bone, after maceration or boiling, or at most, of the general characters of the medulla with which its cancelli are filled. And it results from this superficial mode of study, that there is as yet but

little exact knowledge of the really essential changes which the organic, active portions of bones undergo in disease.

Virchow, who was among the first to examine microscopically the condition of the bone cells in ostitis and some other diseases attended with rarefaction of the bone tissue, (Uber parenchymatöse Entzündung; Virchow's Archiv. Bd. IV. Hft. 2: 1852, b. s. 301 to 311,) formerly regarded the process as essentially a degenerative one, due to the fatty degeneration of the bone corpuscles and the subsequent softening and removal of the area depending on these cells. We have already, however, stated the view which appears most plausible in regard to the removal of the calcareous salts, and so far from fatty degeneration of the bone corpuscles being a constant feature in the different forms of osteoporosis, it would appear from the careful researches of Ranvier (Archives d' Anat. et Phys., Norm. et Path., No. 1, 1868, page 69), that this condition of the cells is altogether characteristic of caries and limited to that morbid process. On the other hand, there is every reason to presume that these cells are influenced by various morbid causes, (inflammation, syphilis, rheumatism, gout, scrofula, &c.) in the same way as the other tissues of the body, and give rise to products more or less characteristic of the diseased action present.

The history of the present case would appear to indicate that the nature of the disease was a rheumatic or scrofulous inflammation, but beyond this mere supposition we are prevented from advancing by the absence of any chemical and microscopical examination of the recent bones.

We would here again call attention to the marked peculiarity of the porotic bones, fully described at pages 24 and 25, and figs. 4 and 17, although we are unable to suggest any plausible explanation of the invariably parallel arrangement of the meshes of the porotic bone, and of the equally uniform vertical arrangement of the meshes of the new-formed sub-periosteal layers.

2. Another important appearance present in the bones here described, and indeed one which is as marked and wide-spread as the osteoporosis, is the extensive development of bone upon the exterior of the original shafts. In our description of the skeleton, we have already noted the peculiarities of these sub-periosteal growths, and it will be remembered that they are in every instance limited to the body or shaft of the bones, and never extend on to the epiphyses, and that they usually present several thin laminæ of imperfectly compact bone, parallel to the shaft and separated from it and from each other by more or less wide interspaces usually occupied by coarse cancellated tissue.

It is undoubtedly from the examination of such specimens as this that the mistaken idea arose that the lamellæ, of which the original compact shaft was formed, had been pushed asunder by the great enlargement of its cancelli. It will, however, be seen from our description that the ap-

pearances contradict any such supposition, and clearly show that while in the cancellated and imperfectly compact tissue of the original shaft a process of rarefaction (osteoporosis) has been advancing by atrophy of the bony lamellæ, there has also been an active process of periostitis resulting in the formation of thick layers of new bone on the exterior.

Another means of distinguishing the line of demarcation between the original shafts and the new-formed layers, is the abrupt change in the direction of the cancelli already referred to.

It is evident, also, that the periostitis has not been uniformly continuous, but that for a variable time its intensity was such that the inflammatory product was capable of but imperfect ossification, and remained as cancellous tissue; while at irregular intervals thin layers of imperfectly compact tissue have been formed. The occurrence of this long standing, but not uniform process of periostitis ossificans appears to account, in every instance, for the changes observed on the exterior of the original shafts. In addition to this uniform hyperostosis, it will be observed from the description (see pp. 23, 24) that the same process of periostitis has given rise to varied forms of porous osteophytes.

3. In some places, however, it is evident that a still further change has occurred, consisting in the gradual conversion of the cancellous tissue into compact bone. This process of consecutive or secondary induration is most marked in the layers of bone formed by the periosteum; though it is present in the shafts of the tibiæ, femora and some other bones. It is manifestly impossible to determine accurately the portions which have been rendered compact by this process, but the disposition of the successive layers of new-formed bone is, in general, so much like that above described, that we are inclined to regard all the areas of compact bone of any considerable thickness as due to this secondary change.

It would, indeed, appear but probable that as the high degree of inflammation, under which the layer of cancellous tissue had been formed, subsided, there should be a tendency to the formation of successive layers of bone on the interior of the walls of the cancelli. It is especially in connection with this point that the result of the microscopical examination of the sub-periosteal layers is of so much interest. It will be observed (see Fig. A) that in the newly-formed compact bony tissue, the lamellæ are arranged concentrically around the vascular canals; a mode of arrangement which strongly points to the occurrence of the process of consecutive induration, as we have above described.

The specimens are deposited in the Museum of the College of Physicians.

J. EWING MEARS, M. D.
WM. W. KEEN, M. D.
HARRISON ALLEN, M. D.
WM. PEPPER, M. D.

Stated Meeting, March 3, 1871.

Present, five members.

Dr. G. B. Wood, President, in the Chair.

Donations for the Library were received from the Dorpat Observatory, St. Gall Society, R. Asylum for Lunatics at Perth, Scotland, the London Royal Society, R. Geographical Society, Society of Arts, and Thomas Irving, Esq., General Sabine, Sir Charles Lyell, the Royal Observatory at Greenwich, Prof. Mayer of Bethlehem, the American Pharmaceutical Association, Franklin Institute, Directors of City Trusts, and U. S. Commission Bureau for the Paris International Exposition for 1867.

The Cylinder presented by Dr. Lowber was laid on the table, and Prof. Cresson called the attention of the members to it.

The death of Wm. J. Hamilton, F. R. S., member of the Society, was announced by Mr. Chase.

Prof. Cope offered for publication in the Proceedings three memoirs, entitled:

"Supplement to the Extinct Batrachia and Reptilia of N. America; by E. D. Cope." (See Proc. p. 41.)

"On two extinct forms of Physostomi of the Neotropical region; by E. D. Cope, A. M." (See Proc. p. 52.)

"On the occurrence of fossil Cobitidæ in Idaho; by E. D. Cope." (See Proc. p. 55.)

Also "Notes relating to the Physical Geography and Geology of, and the distribution of Terrestrial Mollusca in certain of the West Indian Islands; by Thomas Bland."

Prof. Cope exhibited specimens of teeth and portions of the jaw of a new Mososauroid; also slabs of coal slate, containing fossils of a new species of batrachian, and a new reptilian genus.

Mr. Chase offered some additional evidence of the contrast between European and American rainfalls; and communicated some American peculiarities in the relations of barometric pressure of winds and storms. (See below.)

Pending nominations Nos. 669, 670, and new nomination 671, were read.

Mr. Chase made a communication on the subject of providing suitable accommodations for the observations of the Signal Service Bureau, which was referred to the Curators and Hall Committee, with power to act.

And the meeting was adjourned.

European and American Rain-falls.

By Pliny Earle Chase.

(*Read before the American Philosophical Society, March* 3, 1871.)

There is still a lingering skepticism on the part of some meteorologists, regarding the moon's influence on the weather, a skepticism which is perhaps owing to the apparent want of agreement between observations at different places. There is, however, no good reason for expecting such accurate correspondence as is sometimes deemed essential. Dr. Emerson (Proc. A. P. S., XI. 518) has communicated to the Society his early observation upon the reversal of the European barometric prognostics on this side of the Atlantic. Mr. Blodget (Climatology, pp. 221–237) has pointed out various climatologic contrasts, and Mr. Scott, the Director of the British Meteorological Office, has noticed an opposition between the solar (or temperature) rain-falls in Western Europe and Eastern America, analogous to that which I have indicated in the lunar rain-falls. The confirmation thus afforded to the results of my previous investigations, strengthens the presumption that, in our Atlantic States, signs of fair weather may be most confidently trusted during the ten days preceding, signs of rain during the eight days following, full moon.

In order to make a comparison between stations of similar latitude, I obtained from the "Observatorio do Infante D. Luiz," a record of the quarterly rains at Lisbon for sixteen years, which I have embodied, to-

gether with the observations at Pennsylvania Hospital for the same period, in the following tables. The measurements are given in millimetres.

I.—Quarterly Rain-fall at Lisbon.

YEARS.	WINTER.	SPRING.	SUMMER.	AUTUMN.	TOTAL.
1855	280.3	272.7	15.4	362.5	930.9
1856	513.4	300.7	8.5	90.3	912.9
1857	267.8	152.2	67.9	324.4	812.3
1858	224.2	113.2	7.1	567.6	912.1
1859	128.0	201.8	71.6	306.9	708.3
1860	210.9	122.4	39.6	187.3	560.2
1861	501.5	154.3	14.6	311.4	981.8
1862	364.4	282.9	6.6	176.9	830.8
1863	181.8	196.6	64.8	101.6	544.7
1864	155.3	282.2	33.9	363.5	834.9
1865	371.6	159.2	24.4	487.2	1042.4
1866	214.7	365.3	14.6	82.3	676.9
1867	197.2	216.2	13.6	172.1	599.1
1868	162.9	76.9	38.0	279.4	557.2
1869	323.2	158.5	3.1	66.0	550.9
1870	305.7	111.6	21.9	160.3	599.5
Mean	275.2	197.9	27.9	252.5	753.4

II.—Quarterly Rain-fall at Philadelphia.

YEARS.	WINTER.	SPRING.	SUMMER.	AUTUMN.	TOTAL.
1855	193.0	169.9	435.4	257.8	1056.1
1856	284.5	211.8	241.3	187.5	925.1
1857	184 4	359.9	482.6	133.4	1160.3
1858	264,9	272.8	274.1	227.1	1038.9
1859	376.7	376.9	376.4	371.6	1501.6
1860	240.3	229.6	311.7	342.9	1124.5
1861	269.8	362.5	243.3	332.0	1207.6
1862	292.6	254.5	263.1	343.9	1154.1
1863	280.7	442.0	297.4	153.4	1173.5
1864	174.8	448.3	204.2	327.9	1155.3
1865	370.1	374.7	291.9	380.3	1416.9
1866	390.4	247.9	194.6	370.9	1203.8
1867	230.1	370.6	742.5	228.1	1571.3
1868	225.3	401.3	268.0	404.6	1299.2
1869	318.5	296.2	247.7	337.8	1200.2
1870	297.7	404.9	303.8	195.8	1202.2
Mean	274.6	326.5	323.6	287.2	1211.9

It appears, therefore, that the heaviest rain-falls at Lisbon and the lightest at Philadelphia, are usually in the Autumn and Winter semester the heaviest at Philadelphia and the lightest at Lisbon, in the Spring and Summer. In ten years out of the sixteen, when the rain-fall of the entire year was above the average at one station, it was below the average at the other.

American Weather Notes.

By Pliny Earle Chase.

The signal service observations of our War Department have already shown the value both of Buys Ballot's law and of Capt. Toynbee's modification in predicting changes of wind, especially if due regard is paid to the barometric variations of the two previous days. They have also suggested the following general deductions, some of which may perhaps prove to be true only of the winter, while others seem to be explicable by natural circumstances of position and physical configuration, which must be operative at all seasons.

1. Winds varying like the land and sea breezes, are often traceable, especially in the lull which follows the passage of storms, to differences of temperature in the neighborhood of the great lakes, and of mountain peaks and ridges.

2. The wind, especially in the Southern States, often blows directly in the line of the greatest barometric gradient. But even in such cases, after a few hours continuance, it tends towards the azimuth indicated by Buys Ballot's law.

3. The isobaric lines are, therefore, often of less relative importance than the gradients in forming forecasts.

4. Long ridges of high barometer, as observed by Espy and others, with adjacent troughs of low barometer, often traverse the continent, sometimes with slight deflection, sometimes having a semi-circular, circular, or elliptical curvature with a diameter of three thousand miles or more. Such ridges usually have a steeper declivity and stronger winds on their northerly and easterly than on their southerly and westerly sides.

5. Currents with an anti-cyclonic tendency, controlled by arreas of high barometer, are notably common. Reversals of wind, as from N. E. to S. W., are, therefore, frequent after the passage of an anticyclonic ridge or centre, as well as after the passage of a cyclone.

6. Our recent storms have been anticyclonic, and there seems some reason for supposing that anticyclones are the usual "weather-breeders," even of such of our land storms as become more or less cyclonic after they are fully developed.

7. The precipitation of vapor of course gives rise to local cyclones, which, however, may be easily and speedily overborne by the grand anticyclonic whirls of a half million miles or more in area.

8. These and other peculiarities, point to a probable origin of storms in the blending of polar and equatorial currents, near the latitudes at which the general tendency of the winds changes its direction.

9. Mr. Scott has observed that when polar (E.) currents are blowing at the North, and equatorial (W.) currents at the South, a serious barometrical disturbance, frequently resulting in a gale, generally soon follows; but when the polar current is at the South and the equatorial at the North there appears to be no law of sequence. The latter condition, with us, seems often indicative of approaching fair weather, especially if northerly or easterly are separated from southerly or westerly winds by a ridge of high barometer.

10. If the progress of a northerly or easterly current towards the equator is impeded by an intervening southerly or westerly current, the disturbance not only speedily follows, as indicated by Mr. Scott, but it is also, commonly, like most showers, S. E. storms, and other marked cyclonic commotions, of briefer duration than those which are primarily anticyclonic.

SUPPLEMENT to the "*Synopsis of the Extinct Batrachia and Reptilia of North America.*"

BY E. D. COPE.

(*Read before the American Philosophical Society, March* 3, 1871.)

BATRACHIA.

SAUROPLEURA REMEX, Cope.

Proc. Acad. Nat. Sci., Phila. 1868, p. 217. *O. amphiunimus*, Cope. Trans. Am. Phil. Soc. 1869, 17 in parts.

A fine specimen of this species recently sent me by Prof. Newberry, from Linton, Ohio, includes the vertebral column from the hind limbs to the end of the caudal series. One of the former is preserved and exhibits slender digits and other characters like those already described in the *S. pectinata*. Having ascertained that the *Oestocephalus amphiuminus* possesses no anterior limbs, I regard my reference of these species to that genus as premature, and will allow them to remain in *Sauropleura*, where I originally placed them.

OESTOCEPHALUS AMPHIUMINUS, Cope.

Trans. Amer. Phil. Soc. 1869, p. 17; l. c. p. ii.

The bones formerly regarded by me as referable to a rudimental fore limb in this genus, appear to be rather branchihyals, and indicate the existence of external branchiæ.

COLOSTEUS SCUTELLATUS, Newb.

Pygopterus scutellatus, Newberry, Proceed. Ac. Nat. Sci., Phil. 1856. *Colosteus crassiscutatus*, Trans. Amer. Phil. Soc. 1869, 23.

The original description of this species by Prof. Newberry was overlooked, in preparing my account of it above quoted.

MOSASAURIDÆ.

LIODON SECTORIUS, Cope, sp. nov.

Established on a large part of the under and upper jaw, and other parts of the cranium with a vertebra, from the green sand of the upper bed of the Cretaceous of New Jersey.

The character which at once distinguishes this species from other Liodons, and especially from all the species of *Mosasaurus*, is the very compressed form of the crowns of the teeth, which approach nearer in this respect to those of *Diplotomodon*, than any others that I have seen. The vertebra, a lumbar, has also subround articular faces, thus removing the species from close relationship to those with depressed vertebræ, of some of which the teeth are unknown.

In the present specimen crowns and pedestals of thirteen teeth are preserved. Those of the mandible are most numerous, and display the successional modification of form from before backwards visible in other species of the family. The anterior teeth are less compressed, and have

but one, an anterior, cutting edge, the posterior face being regularly convex. The inner face is much more convex than the outer, and the flatness of the latter is marked at the apex of the tooth by a short ridge which bounds it posteriorly. This is a trace of the bounding angle which extends to the basis of the crown in *Mosasaurus*. The anterior cutting edge is in profile convex; the posterior outline concave to near the tip. The cutting edge is acute, and beautifully ribbed on each side, but not properly denticulate. The surface of the tooth is not facetted, but the outer face exhibits the peculiarity of a longitudinal concavity, or shallow groove extending from the base to the middle of the crown. The enamel is polished, but under the microscope minutely and extensively striate ridged. This description is taken from the second or third from the anterior end of the maxillary bone. The third from the distal end of the dentary is very similar.

The crowns become rapidly more compressed as we pass backwards. From a broad oval section of two crown bases, we reach a flattened oval crown, with the cutting edge sharp behind as well as before, and minutely ribbed. The crown is not facetted, and is more convex interiorly than exteriorly. The exterior convexity is chiefly anterior; the posterior face is slightly concave from the open groove already described as present in the anterior teeth. In two posterior crowns, one still more elongate in section, the external concavity becomes flatter and includes a great part of the outer face. A tooth still more posterior presents the peculiarity of the species in the strongest light. The crown is still more compressed, directed backwards, and only .25 higher than wide antero-posteriorly at the base. The latter is a little over twice the transverse diameter just behind the middle. The surface presents the characters described in others. The outer concave surface is wide and shallow, and contributes to the attenuation of the posterior half of the tooth rather than the anterior, which is consequently thicker. The cutting edges are sharp, the anterior convex and retreating backwards to the rather obtuse apex; the posterior convex above, concave below.

The exposed parts of the dental pedestals are frustra of cones, neither swollen nor concave.

Measurements.	*M.*
Third superior maxillary length crown	0.033
" height crown and pedestal	.048
" longitudinal diameter base crown	.02
" transverse	.013
Sixth dentary, longitudinal	.024
" " transverse	.014
Eleventh dentary height crown	.034
" height crown and pedestal	.0505
" longitudinal diameter basis crown	.026
" transverse	.014

The *articular* bone is perhaps .66 the size of that of *Mosasaurus dekayi*

and presents less powerful development of the interior ridge for the pterygoid muscle. The cotylus descends abruptly behind it. The *coronoid* bone exhibits the usual anterior fissure. The rolled front margin of the ascending portion is thickened. The superior surface of the anterior part of the *frontal bone*, is lumpy and with some shallow pits; the outer face of the articular is smooth. The *vertebra* preserved is a posterior lumbar, and is injured; the anterior articular face is nearly round. Its vertical diameter is M.058. Length of centrum M.058.

The forms of the teeth distinguish the *Liodon sectorius* from the species of *Mosasaurus*, and that of the vertebra, from such species as *Liodon perlatus*, Cope, and *L. dyspelor*, Cope. There remain to compare with it, *L. proriger*, Cope; *L. mitchillii*, Dekay; *L. laevis*, Owen; *L. congrops*, Cope; *L. ictericus*, Cope; and *L. mudgei*, Cope. In size it will only compare with the first two species, being from twice to four times as large as any of the remaining four. The flattened teeth distinguish it at once from *L. ictericus*, and the abrupt rising superior margin of the articular bone, from the *L. mudgei*, where the upper and lower margins are for some distance parallel. The less compressed vertebral centrum distinguishes it from *L. laevis*. From the two large species, dental characters separate it. Thus in *L. proriger* the teeth are less compressed, and are facetted, especially the anterior ones, with concave grooves separated by obtuse ribs. In *M. mitchillii* the teeth present more similarity, but are abundantly distinct. They are much less compressed, even where the posterior cutting edge is strongly developed, the external face is convex to the apex and without concave or flat facet; it is narrower at the base as compared with the height, and has an incurvature not seen in this *Liodon*. The enamel is smooth, and not striate under the glass.

This and the *L. mitchilli* are the largest Liodons of the Eastern cretaceous. I have recently obtained three anterior dorsal vertebræ and a tooth of the latter, from the lower bed of cretaceous green sand near Freehold, N. J. The vertebræ rival in size those of *Mosasaurus dekayi*, but are of a more elongate form. The articular extremities are cordiform and nearly round, the posterior with the smooth neck band just in front of its margin. In front of this, the surface is sharply striate, especially on the inferior aspect; the same appears on the bases of the diapophysis. The tooth is like one of those described by Leidy. (Cret. Rept. Pl. XI.)

The *Liodon sectorius* was obtained by Judson C. Gaskill, from the marl pits of the Pemberton Marl Co., at Birmingham, N. J., and liberally placed at my disposal by him.

ADOCIDÆ.

The species of this family display considerable differences in the nature of the sutures of the bones of the plastron. In the thickest species the sutures are fine and the processes very small. This is especially the case with *Adocus pectoralis*. In *A. beatus* which is thinner, the sutures are coarser, but without gomphosis; that between the hyo- and hyposternal elements looking as though a slight mobility existed in life, as I have

observed in a former article. In *A. syntheticus* the sutures are a little coarser, and in *A. agilis* a further increase is seen, but with but little gomphosis. In *A. pravus*, according to Leidy, there is a little gomphosis, but how much is not ascertainable from his figure and description. In *Homorophus insuetus*, a stouter turtle, the gomphosis is very strong, especially in the longitudinal sutures, where the teeth are long and stout. In *Zygoramma* this coarseness of gomphosis reaches a maximum, being strong in all the sutures of the two species, except the anterior mesosternal of

ZYGORAMMA MICROGLYPHA, Cope, sp. nov.

This large species is represented by the greater part of plastron and half of carapace, with four marginal bones, of an individual from the New Jersey cretaceous, of two and a half feet in length. Its discovery is interesting as enabling me to refer this genus to the *Adocidæ* without doubt, a point which the specimens of the original species, *Z. striatula*, Cope, left uncertain.* The episternal bone displays beautifully the wide intergular scutum separating the lateral reduced gulars. The postabdominal bone displays the swellings corresponding to the pubis and ischium. The pectoral dermal scuta advance medially on the posterior part of the mesosternal bone. These characters are those of *Adocus*. On the other hand there is not satisfactory indication of the intermarginal scuta, though they may exist, and the free marginal bones anterior to the bridge display the double articulation, by suture and gomphosis characteristic of *Zygoramma*. It might be here observed that it is possible that this structure will be found to exist in species at present referred to Adocus, *A. agilis*, for example, where the marginal bones are unknown.

This species is one of those in which the mesosternal is received in the very open emargination of the hyosternals, a character indicating the breadth of the former, and seen in *A. agilis* and *A. syntheticus*. The bones are relatively thin, the marginals light and gently recurved. The anterior lobe of the plastron is truncate, the straight anterior margin grooved lengthwise. The posterior lobe is regularly contracted, and rounded, and with thin edge. The xiphisternal and hyosternal of the right side have each an oblique sutural union with the hyposternal of the left. The mesosternal is broader than long. the posterior margin broadly truncate, the latero-posterior curved sigmoidally, the anterior regularly convex. The episternal is but moderately thickened. The parts of the hyposternals on the bridge are nearly in the plane of the rest of the plastron. The marginal bones near those of the bridge have a thickened shoulder above within, into which the slender costal processes are received: they thin out rapidly and are gently everted distally. More distal marginals are lighter and more everted.

The bones of the carapace include three vertebrals and numerous costals. The latter display very weak capitular processes, but in none are they entirely absent. Neither they nor the vertebrals are thickened. The

* Proceed. Amer. Philos. Soc., 1870, 550.

vertebrals are short coffin-shaped, concave or emarginate in front; a stout laminar neural spine supports the vertebra below.

The sculpture of all the bones is a delicate impressed punctation, the impressions forming lines or delicate grooves in some places. These run obliquely across some of the costals and marginals, and sublongitudinally on the posterior lobe of the plastron. The corneous scuta have left distinct impressions. The marginals extended on to the costal bones at the place of the free marginal bones. The vertebrals were a little longer than wide, with bracket shaped lateral sutures, and openly emarginate below. The intergular plate was pentagonal, with straight sides, and broader than long. The gulars are short and not prolonged very far on the outer margin of the plastron. The pectorals are narrowed laterally, and present a convex median outline on the mesosternum. The abdominofemoral suture crosses a little behind the middle of the hyposternal bone. The median longitudinal suture winds from side to side on the posterior lobe in the most erratic fashion, abnormally no doubt, and the suture for the anals is anterior, convex in front, sigmoid at the sides.

Measurements.	*M.*
Length of plastron (restored)	0.457
" from front to postabdominal suture	.34
" " to (right) hyposternal	.195
" " to hyosternal	.104
" " to mesosternal	.038
Width at mesosternal	.194
" of "	.095
" at postabdominal suture	.22
Thickness of mesosternal behind	.0116
" of hyposternal medially	.0158
Width of average costal at vert. scute suture	.055
Thickness of same	.011
Total length adjacent vertebral	.066
Greatest width	.036
Width do. at end	.022
Length of first free marginal from bridge	.0655
Width of do.	.10
Thickness proximally	.0175
" of a free marginal proximally	.01
Width " "	.075
Length " "	.0548

The type specimen of this species is about twice the size of that of *Z. striatula*. It also differs in some respects which might be attributed to age, as the greater recurvature of the marginal bones and the greater extent or prolongation of the thickening on the inside of the marginals next the bridge. But there are others which appear to be specific. Thus there is very little evidence of cross-union of sternal elements in the *Z. striatula*, and the sculpture is twice as coarse and so much more marked.

The pegs of the costal gomphosis are absolutely twice as large, and relatively still larger. I therefore believe this specimen to represent another species. Besides the sutural characters, those of the intergular scuta separate this species from *Adocus beatus*. In the latter that scute is urceolate, and the gulars sickle-shaped, being produced backwards on the margins of the episternal or clavicular bones. In *A. syntheticus* the intergular is narrower, and convex behind, the mesosternum is angulate posteriorly, and the plastron much thicker. In *A. agilis* the plastron is nearly similar in thickness, but the mesosternum is angulate behind, and is narrower, and the sculpture very much coarser.

The *Z. microglypha* was found by my friend, Judson Gaskill, in the marl excavations under his direction, at Birmingham, N. J.

AGOMPHUS, Cope.

This name is proposed for a genus of *Testudinata* heretofore not recognized. It appears to belong to the *Emydidæ* so far as known, but to differ from them in lacking the articulation of costal and marginal bones by gomphosis, characteristic of the existing genera of the family. It does not appear to differ in any other point so far as known. The type-species is *Agomphus turgidus*, Cope (*Emys* Trans. Amer. Phila,, 1870, 127); others from the cretaceous of New Jersey are *A. firmus*, Leidy (l. c. 126) and *A. petrosus*, Cope, (l. c. 126).

(?) PROPLEURIDÆ, Cope.

Sillim. Amer. Journ. Sci. Arts, 1870, (*L*) 137-8.

CATAPLEURA PONDEROSA, Cope, spec. nov.

This turtle is represented by two posterior marginal bones, six costals, a hyposternal, scapula and procoracoid, and femur and humerus, all more or less fractured.

The marginals are the caudal, and adjoining one of the right side. They both present a suture for the pygal vertebral, and the lateral presents also a pit for articulation by gomphosis with the last costal bone. They are of heavier form than those of any other species of the group. The hyposternal has had no sutural union with the hyosternal unless exteriorly; this, if existing, has been slight. The shaft of the humerus is contracted and nearly cylindrical; the great trochanter of the femur is little elevated, and not continuous in the plane of the head, but separated from it by a depression.

The above characters express the generic relationships of this type. The gomphosis with the last lateral marginal, as well as the lack of union of the lateral elements of the sternum separates it from Osteopygis; their union is more extensive than in Propleura sopita. This would not prevent the generic unity of the two, were it not for the additional characters of a slender shafted humerus, and probably broad short mandible with long symphysis. In P. sopita the rami are slender, and the sympysis short. The characters are much like those of Catapleura repanda, and I arrange it with that species until better information compels a change.

The *caudal marginal* is strongly concave below, convex above, the margin little recurved. The anterior outline is convex medially, with straight continuations at right angles to each lateral suture. A portion of the edge is broken off. Lateral marginal strongly and openly emarginate, surface not convex as in the median. Both are massive as in Agomphus firmus and allies. The union with the pygal ceases behind the costal pit.

The *costals* are thick and considerably curved transversely to the vertebral axis, the rib heads are unusually large and prominent and subcylindric in section. The rib ridge is more elevated and rounded in section than in any other species.

The *hyposternal* is from the left side. It exhibits the free articulation for the xiphisternals; the posterior margin is thinned out, while the anterior is more abruptly rounded, and without trace of hyosternal suture. The external face is distally rayed with narrow ridges. The common peduncle of the scapula and procoracoid is short and wide, the sutural face for the coracoid, subtriangular.

The bicipital ridge of the *humerus* is as usual at right angles to the head, and is thin and flat. The plane of the inner crest makes an open angle with the outer; its base is less distant from the shaft than that of the outer. The great trochanter diverges somewhat from the plane of the axis of the head of the *femur*. The latter overhangs the shaft behind; the latter is curved, and beyond the middle subquadrate. In this as in the humerus, one of the two crests is continued as a ridge along the shaft.

Measurements.	*M.*
Length caudal marginal	0.06
Width	.08
Thickness	.0017
Width second ? costal bone	.082
Thickness do. at centre	.013
Width hyposternal at middle	.064
Thickness do. near anterior margin	.012
Length free portion of a rib	.018
Diameter (long) head humerus	.037
" " shaft "	.015
" " head femur	.033
" " shaft "	.016
Width mandible at symphysis at right angles to margin	.034
Thickness mandible at symphysis posteriorly	.011

Accompanying the above remains were those of a small chelydrine turtle, and of a *Taphrosphys*, and a portion of the mandible of a species allied to *Lytoloma augusta* and other species. Its size relates well to the other bones of the *Catapleura ponderosa*, and I suspect that it belongs to that species. It has the expanded form with slightly recurved alveolar margin, of this group; the masseter fossa is strongly marked; the dental

foramen opens almost superiorly; the posterior margin of the jaw is deeply grooved.

The *C. ponderosa* differs from *C. repanda* in its rounded instead of flattened rib-ridges on the inferior surface of the costal bone, and in the different proportions of the crests of the femur. The lesser trochanter in the latter is more robust, and less narrowed and prolonged as a ridge on the shaft. The proximal half of the shaft is straight; in *C. ponderosa* curved.

This species was discovered by John G. Miers, a gentleman who has already enriched palæontology with many interesting forms. From the upper bed of Cretaceous green sand at Hornerstown, New Jersey.

In the nomenclature of the elements of the plastron of the Testudinata, I will in future adopt in part that proposed by Parker (on the shoulder girdle Roy. Society, 1869), who has shown after Rathke that the posterior pieces do not belong to the sternum. The bones from front backwards should then be named, *clavicle* ("episternal"), *mesosternal*, *hyosternal*, *hyposternal*, and *postabdominal* ("xiphisternal").

CROCODILIA.

Bottosaurus macrorhynchus, Harlan.

C. harlani, Meyer. *Bottosaurus harlani*, Agass., Leidy, Cope.

The present state of knowledge of this rare species and genus involve some confusion, and I propose here to set it to rights in a brief manner. This is rendered easy by the discovery of the almost complete skeleton of a nearly grown individual, in the upper bed of cretaceous green sand.

Following my predecessors, I regarded the *Crocodilus basitruncatus* of Owen as this species, in the synopsis Batr. Rept. N. Am., 1869, p. 65, but with expression of considerable doubt. At page 231 of the same work, I distinguished the species of Owen as a true *Holops*. As I had supposed the cervical vertebræ to present the characters of *Holops*, the assignation of the specimens on which this opinion was founded to a species of that genus, left an entire uncertainty as to their character in *Bottosaurus*. The discovery of a series of vertebræ as above mentioned, settles that their structure is not that of the other cretaceous genera, but that of the Tertiary and recent forms, *i. e.*, that the hypapophysis of the cervicals are produced and undivided to the axis. Deducting the erroneously supposed character, there remains one curious feature to distinguish this form from the recent *Alligator*. The fangs of the teeth posterior to the eleventh are not enclosed by the dentary bone, but are exposed to the inner face of the splenial. How far the latter protects them the nature of the specimen does not allow me to decide.

It remains to correct the specific relations of this crocodile. At page 230 of the above work, I described a new species of *Bottosaurus*, under the name of *B. tuberculatus*, establishing it on remains of cranium of one individual and those of the posterior parts of a skeleton of another. The anterior part, with jaws of the latter having fortunately been recovered

as above mentioned, and placed in my hands, I find that the animal belongs to the original *B. macrorhynchus*, and that the first jaw and teeth represent an individual of another species, which will bear the name of *B. tuberculatus*. It differs from the first named in the acute or conic form of the crowns of some of the teeth, and probably in the much smaller size.

In addition to the generic peculiarities already mentioned, this species exhibits a disparity between the lengths of the centra of the lumbar and cervical vertebræ, which is unusual; compare the measurements below with those given for the remainder of the same animal as above cited.

The hypapophysis of the dorsal vertebræ are long, with parallel sides, and oval in section. In that one where the capitular articular face is near the suture of the neural arch, the articular cup is entirely round, and its margin flared out regularly to the capitular surface. The neurapophyses are narrow, and the anterior zygapophyses directed very obliquely downwards.

The *cervicals* are not only shortened, but diminish very much in diameter anteriorly, and the cup continues round. The hypapophysis is very stout on the anterior, more compressed on the posterior vertebræ. The neurapophysial articular faces have the usual rugose anterior and radiate crested posterior areas, but are short and wide, and the anterior area has an oblique concavity extending across it outwards and anteriorly.

The posterior area is, however, the more deeply grooved, especially on the lumbar vertebræ.

The *rami of the mandible* are preserved nearly entire. The large external foramen between the dentary, angular, and articular bones, exists as also the smaller one on the inner face of the ramus. The rami are hollow and thin walled, though of very stout form. The anterior teeth extend along the outer margin of the dentary and then cross to the inner side, the teeth from the twelfth to the eighteenth or last being separated, the first by rudimental septa the latter by mere low ridges. Six of these teeth are exposed without osseous wall on the inner face, and that for the anterior tooth is probably incomplete. The whole length of the ramus is about twenty-eight and a half inches. It is elevated at the position of the tooth usually called the inferior canine; this may be made to appear like an external expansion by rotating the ramus outwards (see Leidy Cretaceous Rept. U. S., Tab. IV. fig. 20). There is another elevation at the seventh tooth behind this point, and a concave curve to the elevation of the articular bone. The angle of the jaw is prominent. The cutting edge is rather obtuse and delicately ridged transversely; the rest of the crown is rugose-striate.

Measurements.	*M.*
Length ramus mandible	0.780
Length series of last seven teeth	.160
Depth ramus at twelfth tooth (from front)	,084
" at external foramen	.145

Measurements.	*M.*
Length centrum anterior lumbar	.055
Diameter cup do.	.042
" neurapophysis do	.043
" " dorsal	.027
" cup of centrum "	.035
Length base hypapophysis	.03
Length centrum median cervical	.051
Width cup " "	.037
Depth " " "	.035
" " anterior "	.029
Width " " "	.032
" between post. marg. parapophyses	.045
Depth of centrum to lower edge	.04

Bottosaurus macrorhynchus, Harl., was then a crocodilian with a body of the proportions of our alligator, but with larger legs, and relatively considerably larger head. The cranial bones, however, are much less massive, as though to reduce the weight which would prove inconvenient to a body of no larger size. The bones of the mandible are thin and enclose large pneumatic cavities; the teeth are hollow and with thin walls.

I am indebted to Judson C. Gaskill for the opportunity of examining this interesting fossil.

DINOSAURIA.

Hadrosaurus cavatus, Cope, sp. nov.

This species is indicated by remains derived from the upper green sand bed of the upper Cretaceous of New Jersey. They belong to an individual of the gigantic proportions characteristic of the four known species of the genus. It is smaller than *H. tripos* or *H. occidentalis*, and in a less degree smaller than the *H. foulkei*. The remains consist of four caudal vertebræ from the median part of the series, three of them exhibiting rudiments of the diapophyses. In two of them the neural arch remains, one with the spine, and the articular prominences for the chevron bones are nearly complete.

The first character which is observed in these vertebræ is their opistho coelian articulation. The posterior concave face is marked by a more or less prominent elevated band descending from the end of the floor of the neural canal, and which is sometimes grooved medially. The convex extremity is swollen in the middle, most especially so at three points, and a groove or depressed band which has less than one fourth the width of the centrum, extends round the margin outside of it. The general form of the extremities is rounded hexagonal, the anterior a little depressed, the posterior a little compressed. The sides of the centra are quite concave. The chevron articular projections are quite prominent, terminating ante-

riorly in a low ridge which extends to near the anterior face. At the latter position chevron articuar faces are either wanting or very little marked. The centra exhibit no lateral angulation; the third from the anterior has a trace in a longitudinal fulness above the middle of the side; the last, the same, below the middle of the side. The margins of the extremities are well flared. The neural canal is a little compressed and deeply excavated in the centrum. The surface of the centrum is only rugose at the base of the diapophysis. The general form viewed laterally is subquadrate, the anterior vertebra a little deeper than long, the posterior a little longer than deep.

Measurements.	*M.*
Length centrum of anterior	0.66
Depth posterior face	.071
Width "	.084
" of both chevron processes	.05
" of neural canal	.023
Depth neural canal	.023
Length neurapophysis	.04
Third vertebra, depth posteriorly	.071
" depth posteriorly with chevron process	.078
Fourth vertebra, width centrum behind	.075
" depth "	.066
" " with chevron process	.074
Width neural canal	.02
" " spine	.025
" neurapophysis	.034

The measurements of depth of centrum are made from the floor of the neural canal, not from the upper margin of the superior lateral projections of the articular faces.

As in *H. foulkei*, the neural spines have a small antero-posterior diameter, and the zygopophyses are little developed. The anterior are subacuminate and more or less joined together. As the neural spine is very oblique, the posterior zygapophyses are above a point behind the articular extremity of the centrum.

This species differs at once from the *H. tripos*, *H. foulkei* and *H. minor* in the opisthocoelian vertebræ, resembling in this respect the *H. occidentalis* (Thespesius, Leidy). The latter differs from *H. cavatus* in the development of the chevron articulation equally on both adjacent centra, instead of on the posterior extremity only. In *H. foulkei* and *H. tripas* this double junction of chevrons extends to the extremity of the caudal series, adding another important ground of difference between them and the *H. cavatus*. The single caudal vertebra of *H. occidentalis* known, is like that of the former species in this respect, but there is no certainty that the structure continues the same throughout the caudal series, and that the distal vertebræ may not be like those of *H. cavatus* in this re-

spect. It, however, further differs in the relatively more compressed or oval centrum, and much greater size. From *H. minor* the present reptile differs in the opisthocoelian vertebræ, the known caudals of the former having plane articular surfaces, and in the much larger size. It is not possible to compare similar parts of this species and the *Ornithotarsus immanis*, Cope, but the larger size and much lower stratigraphic horizon of the latter renders their identity very doubtful.

Should the genus *Thespesius* of Leidy turn out to be well established, the present species will enter it. I am not, however, entirely satisfied that the difference in the form of the articular faces of the caudal vertebræ is such as indicates generic difference. It was on this ground that I referred this form to *Hadrosaurus* (in Synopsis Extinct Batr. Rept. N. Amer., p. 98), and not from misapprehension of Leidy's definition of it, as the latter supposes (Proceed. Aca. Nat. Sci., 1870, p. 67).

The rather slight material above described is fortunately so characteristic as to enable us to establish satisfactorily the existence of another monster of the remarkable group of the Dinosauria; beings, whose appearance and structure have rivalled the strangest creations of the imagination, and shown again what every other page of the book of nature teaches, that reality is stranger than fiction.

On Two extinct forms of Physostomi of the Neotropical Region.

By E. D. Cope, A. M.

(*Read before the American Philosophical Society, March* 3, 1871.)

Fam. ELOPIDÆ.

Prymnetes, Cope.

Dorsal fin above the anal with short basis and very elongate rays; the posterior ray free and longer than the others. Ventrals posterior. Vertebræ with deep lateral grooves, disproportionally numerous in the abdominal region, viz.: Abd. 49, caudal 18. Tail deeply bifurcated, its exterior or supporting rays, like those of the dorsal, ventral and pectoral, very stout and obliquely segmented. Head short, mouth (in the specimen) inferior; teeth simple, small. Scales with many concentric grooves and a few radii on the proximal portion. No lateral line discoverable.

The pertinence of this genus to the Elopidæ is indicated in various ways. The general form is that of *Elops* and *Megalops*, and the normal and supernumerary ribs are quite as in the former. The interneural spines extending from the head to the dorsal fin, are quite like those of the same genus. It differs from both in the posterior position of dorsal fin, and relatively numerous abdominal vertebræ. From *Elops* it differs especially in the long posterior lash-like ray of the dorsal, and the deeply grooved vertebræ.

Prymnetes longiventer, Cope, sp. nov.

Established on a very fine and nearly perfect specimen, preserved on a

block of lime slate from Chiapas, Mexico. The body is seen in profile, but the head has been pressed from above, and the view is therefore oblique.

The general form is elongate. The pectoral fins are inserted at the pectoral plane, and are of moderate length. The ventrals are short and small. It is uncertain whether they reach the anal, as the anterior part of that fin is destroyed. From the small number of interhæmal spines, the anal has probably had a short basis. Caudal lobes narrow. A strong horizontal interneural spine. The anterior interneurals are like those of *Megalops*, slender, gently curved rods, apparently, but not really continuous with the neural spines in some places. The dorsal fin laid backwards extends to the emargination of the caudal. The vertebræ near the head are not altered. There appears to have been a laminiform crest on the head, but the bones thus described may be those of the opposite side of the cranium. The muzzle appears to be contracted and projecting beyond the mouth. Three narrow obtuse teeth appear on the edge of the premaxillary bone. Dentary bone, stout. Orbit, round, large; entering 4.66 times the head to the posterior margin of the operculum, and 1.33 times the length of the muzzle. Operculum rounded.

Radii; D. 2. 13. 1, C. ?. ?. 6, 6, A. ? V. ? I. 7. P., apparently not numerous, but very numerously divided. There are about twenty-five longitudinal series of scales at a point a short distance anterior to the ventral fins.

	M.
Total length	0.530
Length to orbit	.024
Vertical diameter of orbit	.018
" dentary bone	.016
Length to opercular border	.086
" ventral fins	.310
" dorsal "	.363
" basis caudal	.380
Depth at pectoral fins	.085
" ventral "	.074
" posterior margin dorsal	.04
" basis caudal	.02

This species was found near Tuxtla Chiapas, Mexico, by Dr. J. Berendt, and by him sent to the Smithsonian Institution. Mus. No. 9819–20.

Fam. (?) CHARACINIDÆ.

Anædopogon, Cope.

Mouth opening almost vertically upwards. Dentition weak, consisting of lancet shaped teeth on the dentary and premaxillary bones; maxillary without or with minute teeth. Post-temporal bone large. Scales with few radii, no concentric grooves or cells.

The pertinence of this genus to the *Characinidæ* cannot be considered as entirely established, as the specimen described does not display any of the fins. The appearance is not unlike that of *Osteoglossum*, but the structure of the scales distinguishes it. The great development of the *sub-* and *postorbital bones*, and small size of the preorbital, distinguish it as allied to the Characins. Its dentition and general form approach the genus *Anacyrtus* Müll. but it is at the same time distinguished by the lack of maxillary teeth. In addition, it appears to lack the anterior interneural spines found in so many Characin and Clupeoid genera, and in families allied to them. They are at least not apparent on the faces of two fractures across the vertebral column. Three *vertebræ* are exposed throughout their length. They are longer than deep, and exhibit the two lateral grooves common to so many Teleosts. The only *scales* preserved are those above the pectoral fins, with but few above the vertebral column. None of these present traces of the lateral line. The *clavicle* makes a right angle with its inferior limb, and with the coracoid, and is produced backwards at the base of the pectoral fin. The *epiclavicle* and *post-temporal* are wide bones. The *operculum* is developed upwards to the epiotic, and the interoperculum is present. A fragment represents the *subopercuIum*, which was probaly a narrow bone. The *coracoid* was a broad vertical lamina, extending horizontally forwards to below the preoperculum.

ANÆDOPOGON TENUIDENS, Cope.

Orbit round, its diameter entering the length of the head five times, and a little exceeding that of the muzzle and closed under jaw. The profile is gently descending and perhaps slightly concave; the symphysis mandibuli is very stout and presents an angle outwards; the inferior margin of the dentary is slightly convex. The maxillary bone is slender. The suborbital bones together form a shield deeper than wide; with the postorbitals they reach the preoperculum. The head increases rapidly in depth. The scales are large, and extended below the operculum on the sides of the coracoid region. They have smooth margins, and are everywhere quite thin. The surface is glistening, and in some scales exhibits under the microscope delicate parallel lines which separate short concave lines. The middle of the scale is marked with obtuse tubercular radii, or small or minute tubercles.

Measurements.	*M.*
Length of head	0.14
" of mouth	.061
" of coracoid bone	.091
Depth head at eye	.093
" " vertex	.126
" suborbital bone	.044

Six series of scales between basis of pectoral fin and vertebral column. A mandibular tooth is lancet shaped, and with minutely striate enamel. A premaxillary is more conic; both are rather small.

This species may have more affinities with *Amia* than with the *Characinidæ*. A single specimen was obtained in a clay nodule by the naturalists of the U. S. Paraguay Expedition under Capt. Page, from the neighborhood of Para. It was accompanied by several specimens of a fish from other nodules, which closely resembles an *Aspidorhynchus*. Museum of the Smithsonian Institution.

On the occurrence of fossil Cobitidæ in Idaho.

By E. D. Cope.

(*Read before the American Philosophical Society, March* 3, 1871.)

Of the five genera of extinct Cyprinidæ and allied forms discovered by Capt. Clarence King* in the fresh water deposit of Catharine's Creek, etc., Idaho, the writer has been able to indicate the affinities of three. Thus *Semotilus*, *Anchybopsis* and *Mylocyprinus*, were regarded as representations of existing types of both carnivorous and herbivorous habits. *Oligobelus* and *Diastichus* were not assigned to any definite position in relation to known types of the same great group, and I am still compelled to leave the former in the same uncertain position. *Diastichus* I find, on the other hand, presents the peculiar direction of the pharyngeal teeth which is characteristic of the *Cobitidæ*, and I suspect that it represents a form of that family. I am entirely confirmed in this conclusion by the discovery, among the specimens submitted to me by the Smithonian Institution, of the inferior element of the three modified anterior vertebræ, which are so characteristic of certain families of the *Physostomous* fishes. This portion, moreover, is that which occupies this position among the *Cobitidæ* only among them. It consists of a longitudinal plate terminating posteriorly in a bladder-like chamber on each side, each of which is closed below by a transverse process of the inferior plate: an angular fissure extends round the ends of these, and at the angle sends a short continuation upwards. This is quite similar to what is observed in *Cobitis*. The specimen described is apparently adult, and indicates a considerably smaller species than either the *Diastichus macrodon* or *D. parvidens*.

The occurrence of Cobitidæ is perhaps the most interesting fact brought to light by the examination of these extinct fishes. All of the numerous existing species are found in the Eastern Hemisphere, and the great majority in tropical Asia, a few only occurring in Europe and South Africa. Extinct species are found in the Miocene of Oeningen. We have, then, in the genus *Diastichus* another example of the occurrence of Asiatic types in North America prior to the glacial epoch, and as in a freshwater fish, strongly suggestive of continuity of territory of the two continents.

* See Proceed. Amer. Philos. Soc., 1870, 539.

Notes relating to the Physical Geography and Geology of, and the Distribution of Terrestrial Mollusca in certain of the West India Islands.

By Thomas Bland.

(Read before the American Philosophical Society, March 3, 1871.)

In 1861 I published (Ann. Lyc. Nat. Hist., N. Y. VII.) a paper on the Geographical distribution of the genera and species of land shells of the West India Islands, and in 1866 (American Jour. of Conchology, I.) further papers on the same subject. From a study of such distribution, without reference to the Physical Geography or Geology of the Islands, I arrived at the conclusion that they may be divided into the five following provinces or sections, each having a distinct faunal character, viz.:

I. Cuba with the Isle of Pines, Bahamas, and Bermudas.

II. Jamaica.

III. Haiti.

IV. Puerto Rico with Vieque, the Virgin Islands, Sombrero, Anguilla, St. Martin, St. Bartholomew, and St. Croix.

V. The Islands to the south of those last mentioned, to and inclusive of Trinidad.

I remarked that the Islands to the West of Puerto Rico have the greater generic, as well as specific alliance with the North American Continent (Mexico and Central America, of course, included), and those to the East and South, with tropical South America.

Within the last year I have endeavored to learn, if any and what evidence may be gathered from the depth of the sea around, and in the vicinity of the Islands, of their former greater proximity to each other and the adjacent continents, sufficient to account for or throw light on the observed facts of land shell distribution. The result is extremely interesting, and in the main confirmatory of the views above expressed.

The British Admiralty Charts have afforded data, chiefly to the 100 fathom line of soundings only, while recently, through the kindness of Mr. Rawson W. Rawson, Governor in Chief of Barbados and the Windward Islands, I have obtained particulars of the deep sea soundings, taken in the Caribbean sea, especially for Telegraph Cable purposes, by United States and British Naval Officers, which supply information of great value, as I propose in this paper to show. I am also indebted for much information to "The West India Pilot," published by the British Admiralty.

I reserve, for another opportunity, observations on the faunas of the first three of the above mentioned sections, now confining myself to the fourth and fifth, with incidental reference to that of the second. Since the date of my former papers, my knowledge of the species inhabiting the Islands embraced in the latter sections has been largely increased, for which my acknowledgments are due principally to Mr. Robert Swift, of St. Thomas, Dr. Cleve, of the University of Upsala, Governor Rawson, and Mr. R. J. Lechmere Guppy, of Trinidad.

SECTION IV. *Puerto Rico with Vieque, the Virgin Islands, Sombrero, Anguilla, St. Martin, St. Bartholomew, and St. Croix.*

Puerto Rico, Vieque and the Virgin Islands, of which Anegada is the most eastern, stand on one and the same bank, an elevation of which to the extent of somewhat less than 40 fathoms (240 feet) would unite the whole, converting them into one Island. Sombrero is on another bank, about 40 miles from the Virgin bank, and 23 miles from the north end of the Anguilla bank. The depth of the channels which separate the Sombrero bank from the Virgin bank on the west, and the northern end of the Anguilla bank to the east, is not known, but soundings are recorded, at their margins, of 160 fathoms (960 feet) and 190 fathoms (1,140 feet), without bottom.

Anguilla, St. Martin and St. Bartholomew stand on the western edge of another bank of considerable extent. Its southeastern end is 14 miles only from the Antigua bank, and the depth of water between the two is upwards of 122 fathoms (732 feet). An elevation of the Anguilla bank of about 40 fathoms (240 feet) would unite the Islands upon it.

The land shell fauna of the above named Islands is unquestionably the same; it has some alliance with that of Haiti, but very little with that of the Islands to the south of the Anguilla bank. Not only is the absence of certain genera prevailing in Sections I., II., and III. noticeable, but the diminished number of representatives of others is equally so, for example:

	in § I.	§ III.	§ IV.
Megalomastoma	13 species,	1	3
Alcadia	9 "	2	1
Strophia	27 "	2	2
Macroceramus	35 "	10	2
Cylindrella	93 "	28	6

The fact that *Megalomastoma*, *Alcadia*, *Strophia*, and *Macroceramus* are not represented in the Islands south of the Anguilla bank (§ V.) and that in those Islands there are 4 species only of *Cylindrella*, affords striking proof of the difference of their faunas.

St. Croix is not unfrequently classed with the Virgin Islands, from which it is 35 miles distant, but it stands on a bank disconnected from any others and with very deep water around it. Soundings are on record (taken, I believe, by Capt. Parsons, R. N,), between it and the Virgin bank, about the mid-channel, of 1,550 fathoms (9,300 feet), and not far from its northern shore of 2,000 fathoms (12,000 feet), without bottom being found.

The following soundings to the eastward were obtained by the U. S. S. Yantic, in 1870, between St. Thomas and Saba:

		fathoms.	feet.
N. Lat. 18° 01′ 50″.	W. Long. 64° 10′ 20″.	—1,825 =	10,950
" 17° 55′ 00″.	" 63° 50′ 30″.	—1,240 =	7,440

Considering the facts of distribution already given, and the above mentioned soundings, it seems highly probable that very deep water will be found between the Anguilla and Antigua banks.

In this connection it is interesting to notice that the depth of the sea is 1,376 fathoms (8,256 feet) between Cuba and Jamaica, in N. Lat. 18° 36′, W. Long. 76° 03′, a somewhat near approximation to the Latitude of the great depth between the Virgin bank (St. Thomas) and Saba.

The fauna of St. Croix is closely allied to that of Puerto Rico, and seeing the depth of water between them, it is a significant fact that *Caracolla* (*Helix*), *caracolla L.* one of the characteristic species of the latter, is found subfossil only, with other extinct species, and among them a *Strophia*, in the former. *Megalomastoma*, *Alcadia*, and *Macroceramus* do not exist in St. Croix, while there is one species of *Cylindrella*. With further reference to the soundings, the Latitude of Jamaica, and the nature of the fauna of St. Croix, I should mention that *Megalomastoma* and *Strophia* have none, and *Macroceramus* one representative (a Cuban species) in Jamaica, in which Island there are, however, 14 species of *Alcadia* and 51 of *Cylindrella*. Sombrero has one living species (*Chondropoma Julieni* Pf.) which is also found, with a *Strophia*, embedded in the phosphatic limestones of that Island.

Professor Cope lately referred to me, for determination, shells from the matrix between the femoral condyles of *Loxomylus latidens*, Cope, one of the great extinct Rodents, the bones of which have been found in the caves of Anguilla. The shells are closely allied to *Tudora pupaeformis*, Sow, now living on Anguilla, and apparently identical with an undetermined species which inhabits St. Martin.

Section V.—*Subdivision* 1. *Islands on the St. Christopher and Antigua banks, Montserrat, Guadeloupe, Dominica, Martinique, and Barbados**.

Subdivision 2. *St. Lucia, St. Vincent, Grenada and the Grenadines, Tobago, and Trinidad.*

In former papers I did not treat the fauna of the Islands in this section as capable of subdivision, but with my present increased knowledge must necessarily do so.

Immediately to the south of the Anguilla bank there is, to the eastward, a bank on which stand Barbuda and Antigua, and to the westward, another (separated from the adjacent Islands by channels of a greater depth than 200 fathoms, 1,200 feet), which constitutes the base of St. Eustatius, St. Christopher, and Nevis. At a short distance from the northern end of the latter bank stands Saba (about 2½ miles in diameter,) rising perpendicularly from the sea to the height of 2,820 feet, with the 100 fathoms (600 feet) line of soundings about half a mile from its western, and a little more than half that distance from its eastern side. Late soundings between St. Eustatius and Saba (Lat. 17° 31′ 10″, Long. 63° 08′ 30″) give a depth of 343 fathoms (2,058 feet).

* I omit mention of several small Islands geographically belonging to those enumerated in both subdivisions.

Within 3 miles S. W. from Saba is the Saba bank, which forms nearly a parallelogram, its longest sides about 32 miles and its shortest about 20 miles in extent, the eastern edge fringed with a narrow ledge of living coral, sand and rock, nearly 30 miles in length and varying in depth from 6½ to 10 fathoms.

It is remarkable that an elevation similar to that mentioned with reference to the Virgin and Anguilla banks (less than 40 fathoms,) would unite Barbuda and Antigua, also St. Eustatius, St. Christopher and Nevis, and convert the Saba bank into an Island.

With respect to Guadeloupe, Dominica, Martinique, &c., the following particulars of soundings lately taken by the U. S. S. "Yantic," Commander Irwin, are extremely interesting:

Between			fathoms.	feet.
Antigua and Guadeloupe,	Lat. 16° 40′.	Long. 61° 48′.	348 —	2,088
Guadeloupe and Dominica,	" 15° 45′.	" 61° 37′.	850 —	2,700
Dominica and Martinique,	" 15° 06′.	" 61° 20′.	1,078 —	6,468
Martinque and St. Lucia,	" 14° 17′.	" 61° 04′.	1,232 —	7,392
St. Lucia and St. Vincent,	" 13° 33′.	" 61° 20′.	1,346 —	8,076

Capt. Parsons, R. N., found on a line of soundings from St. Vincent to Barbados, depths of 350, 956, 1,218 in (about) Lat. 13° 05′, Long. 60° 25′, 1,211, and 147 fathoms, the greatest ascertained depth being equal to 7,308 feet.

The same officer obtained the following results from soundings between Barbados and Tobago, viz.:

		fathoms.	feet.	
N. Lat. 13° 00′.	W. Long. 59° 40′.	300 —	1,800	
" 12° 40′.	" "	570 —	3,420	
" 12° 30′.	" 59° 50′.	780 —	4,680	
" 12° 10′.	" 60° 05′.	1,030 —	6,180	
" 11° 40′.	" 60° 10′.	1,060 —	6,360	
" 11° 27′.	" 60° 25′.	500 —	3,000	without bottom.

I have already given the depths between Martinique and St. Lucia, that Island and St. Vincent and the latter and Barbados. St. Vincent is separated from the northern end of the Grenada bank, on which Grenada and the Grenadines are situated, by a narrow channel, not over, Capt. Parsons remarks, 300 fathoms (1,800 feet) deep. The Grenadines consist of a chain of Islands and rocks extending for 60 miles between Grenada and St. Vincent. The depth found on soundings taken by the "Yantic," gave on and near to the west side of St. Vincent, in about the Latitude of its northern end, 1,080 fathoms (6480 feet), opposite the channel to the south of St. Vincent 594 fathoms (3,564 feet), and along the West side, in close proximity to the Grenada bank, from North to South, 880 fathoms (5,280 feet), 801 fathoms (4,806 feet), 916 fathoms (5,496 feet), and 545 fathoms (3,270 feet).

Trinidad and Tobago are on soundings (less than 100 fathoms), both being in fact on the submarine slope of the South American Continent, and the deeper water found by the "Yantic" between the former Island and the Grenada bank, in (about) Lat. 11° 50′, Long. 61° 45′, was 386

fathoms (2,316 feet), while the maximum depth known, as above stated, between Tobago and Barbados, is 1,060 fathoms (6,360 feet).

It appears from the foregoing evidence, that Trinidad, Tobago, the Grenada bank (an elevation of which to the extent of 40 fathoms would give an Island nearly 100 miles in length), and St. Vincent, stand on a partially submerged ridge, an extension of the South American Continent, having, say, 1,000 fathoms depth of water on the west side, and still greater depths between its northern termination and St. Lucia, also on its eastern side between it and Barbados, and between the latter Island and Tobago. The summit of this ridge is 2,316 feet beneath the level of the sea between Trinidad and the Grenada bank, and, say, 1,800 feet between that and St. Vincent, while the altitudes above the sea are, of Trinidad 3,100, Tobago 1,800, Grenada 2,746, and St. Vincent about 3,000 feet.

The genera and species of land Mollusks which occur in the Islands on the "submerged ridge" just mentioned (Trinidad to St. Lucia inclusive), are chiefly allied to those which are characteristic of Venezuela, the portion of the Continent contiguous to Trinidad. The species of *Helix*, in its wide application, including *Stenopus*, *Hyalina*, and *Zonites*, are 15 only in number, while there are of *Bulimus* (as restricted by Albers) 5, and of *Bulimulus* 14 species, the total number of species of the latter in the West Indies, being about 38. The subgenus *Dentellaria* (*Helix*) is characteristic of the Islands embraced in Subdivision 1 of Section V., but has few representatives in those named in Subdivision 2. *D. perplexa*, Fer., is peculiar to the Grenadines and Grenada, *D. Isabella*, Fer., is common to one of the Grenadines, Barbados, and Cayenne, (French Guiana,) and *D. orbiculata*, Fer., to St. Lucia, Martinique and Cayenne.

The genus *Bulimus*, of which the subgenera represented are *Borus*, *Pelecychilus*, and *Eurytus*, all South American, occurs in the West Indies only in the group (subdivision 2) embracing St. Lucia and Trinidad and the intermediate Islands. *Borus oblongus* inhabits Barbados, but it was introduced there from St. Vincent by the late Rev. Mr. Parkinson. *Eurytus aulacostylus*, Pf., occurs both in St. Lucia and Demerara. With respect to Trinidad, it is certainly curious that we have there a species of *Diplommatina* (*D. Huttoni*, Pf.) and of *Ennea* (*E. bicolor*, Hutton), the latter found also in Grenada and St. Thomas, both living in the East Indies. Guppy has lately discovered a species to which he has given the generic name of *Blandiella*, but it is, I think, a *Truncatella*, allied, at least, to the subgenus *Taheitia*, H. and A. Adams, the type of which is *T. porrecta*, Gould, of Taheiti.

The land shell fauna of the Islands in subdivision 2 have marked alliance with that of Cayenne. There are on that group six species of Helix which are also found in Cayenne, viz.: *Dentellaria orbiculata*, *nux-denticulata*, *dentiens*, *Isabella*, *badia*, and *Thelidomus discolor*. The genus *Cyclophorus* has no less than seven species in Martinique, Dominica, and Guadeloupe, but none in any other part of the West Indies, while one, a different species, inhabits Cayenne. In Barbados no member of the family Cyclostomacea has been discovered. I have already referred to some other peculiarities of this fauna as compared with that of the Islands

embraced in section IV, and should add that Dentellaria *does not* occur in those Islands. *Helix* predominates over *Bulimus* in North America and the Islands in Sections I., II., III., and IV, while the reverse is the case in South America, and there is at least an increased proportionate number of *Bulimus*, as compared with *Helix* in Section V.

I have spoken of a "ridge" on which the Islands in subdivision 2 of that section stand (St. Lucia excepted), and must remark in addition, that there may have existed an extension of the South American Continent, from the eastern boundary of Guiana to some point west of the Grenada bank, and running North to the neighborhood of the Anguilla bank, on the western side of which extension there was the fauna now to be studied in the Islands from St. Lucia to Trinidad, and on the eastern side, in those from the St. Christopher and Antigua banks to Barbados.

Reference has been made to the similarity of depths in nearly the same Latitude between Jamaica and Cuba, and Saba and the Virgin bank.

Mr. Rawson has directed my attention to a comparison of the following depths in the Caribbean sea, ascertained by soundings between Kingston (Jamaica*) and Chagres, and those between Barbados and Tobago:

Lat. 12° 00′. Long. 79° 25′—924 fa. Lat. 12° 10′, Long. 60° 05′—1,030 fa.
" 11° 25′, " 79° 30′—969 fa. " 11° 40′, " 60° 10′—1,060 fa.

Taking a wide view of land shell distribution in the West Indies, it may be said that the fauna of the Islands on the northern side of the Caribbean sea, from Cuba to the Virgin and Anguilla banks, was derived from Mexico and Central America, and that of the Islands of the eastern side, from the Antigua and St. Christopher banks to Trinidad, from tropical South America. It is noticeable that the mountains in the former Islands, range, generally, from West to East, but in the latter from South to North, excepting in Tobago and Trinidad, where they are parallel with, or in the same direction as the coast mountains of the adjacent continent.

The present geological condition of the Islands affords ample evidence of the lapse of vast periods of time in the earlier tertiary epochs, during which the Limestone formations, extensively developed in most of the Islands, were deposited. The white Limestone of Jamaica, referred by Sawkins (Geology of Jamaica, London, 1869), to the Post Pliocene, covers more than three-fourths of the Island and is computed at 2000 feet in thickness. It rests on the yellow Limestone (Miocene), which, he remarks, during the deposition of the former, "sank to great depths, in some places apparently 3000 feet, so as to permit the growth of those great coral structures, from the débris of which the enormous calcareous development of the white Limestone has been derived. The lapse of time required for these important phenomena cannot be easily realized by the imagination."

That the Islands, or some of them, were formerly united and formed part of an ancient continent, may, it would seem for various reasons, be nferred, and the discovery of mammalian and other remains in Anguilla, Sombrero, etc., is an important one.

* The Pedro bank, within 50 miles of the southern shores of Jamaica, with an elevation of 30 to 40 fathoms would give an Island 100 miles long, 30 in breadth near its centre, and 45 at its western edge.

Referring to the Anguilla cave remains, Prof. Cope remarks (Proc. Acad. N. S. Phila., 1868) on their indicating "that the Caribbean continent had not been submerged prior to the close of the Post-pliocene, and that its connection was with the other Antilles, while a wide strait separated it from the then comparatively remote shores of North America."

The occurrence with the Anguilla fossils of a land shell of a species now living, points to the age of the existing fauna, but the marked difference, both generic and specific, between the present land shell fauna of the Islands upon and to the North and West of the Anguilla bank and those to the South of it, may be taken as evidence of their early and continued separation.

Captain Parsons, in MS. Notes on the Geology of some of the West Indies, for a perusal of which I am indebted to Mr. Rawson, observes that the eastern or windward edge of the Grenada bank is at an average distance of 7 miles from the Islands, while the western edge is not more than two-thirds of a mile, and that there is a similar great disparity in other of the banks and Islands. He concludes that such increased development of the eastern over the western sides is primarily due to the equatorial current, which running for ages through the Islands has brought and deposited material on the windward side.*

On this subject, the following quotation from "The Natural History of Barbadoes," by the Rev. W. Hughes, London, 1750, is really interesting, and particularly so in connection with the views of Sawkins with regard to Jamaica.

"The current of the Deluge between the Tropics ran from East to West. Notice the shattered condition of the eastward side of the chain of hills and cliffs, which are as barriers to the Island (Barbados), from Cuckold's Point to Conset's Bay, for as they face the East their torn state on that side alone and no where else, shews that they not only by their situation, first stemmed, but as they were higher than any other part of the Island, they wholly bore the repeated percussions of the current in the gradual ascent of the Deluge. Notice, also, the coping figure of the Island from East to West, for if we view narrowly the several gradual descents of so many continued ridges of rock, like cascades, descending precipitously to the westward (for instance, the long chain of hills from Mount Gilboa, in St. Lucia's Parish, to the Black Rock in St. Michael's), we shall conclude from the deep soil on the eastward of these where the land is level, and from the rugged and bare washed surface of the west, that the latter was thus torn by the violence of the waters falling over them, and the former, the effect of the subsided sediment upon the decrease of the Deluge. The want of such a bed of rocks from Black Rock to St. Anne's Castle caused the chasm which opens to the sea through Bridgetown opposite to the Valley of St. George's. The course of the gullies is, too, from East to West, and they were caused by the current of the Deluge, the regular course of which to the westward between the tropics was the natural consequence of the easterly trade wind."

* In the Bahamas the Islands are, generally speaking, on the windward side of their respective groups and banks.—(*Nelson.*)

Sawkins, in the Report on Jamaica, to which I have already referred, shows that the highest elevations on that Island are situated to the east, and the inclined slope rises from the west. With respect to this, he draws "deductions from two important elements:

"1. The great equatorial currents have existed in times past as at present.

"2. That the trade winds also prevailed with the same uniformity."

Referring to vestiges of volcanic action and certain stratified deposits towards the eastern end of the Island, containing pebbles and debris of previously existing rocks, Sawkins remarks: "This (volcanic) action might have operated intermittently, so as to permit the growth of coral reefs, marine animals, &c., of which the remains are contained in the limestone formations. Again, supposing the deposits to have originated from local igneous or volcanic action, or from debris derived from islands to the east, submersion having intervened, the lighter materials and finer sediment would be transported by the currents to the westward, these influences combining with subsequent changes of level, account for the prolongation of the land to the westward."

In connection with the facts stated I can only incidentally refer to the barrier presented by Trinidad, Tobago, the Grenada bank, and St. Vincent to the distribution, to the westward, of marine forms living at greater depths than 400 fathoms; and to the same barrier and others offered by the Islands and banks to the North of St. Vincent, to the flow of the equatorial current into the Caribbean sea. Also to the existence of a cold current at great depths between Barbados and Tobago, shown by the temperatures ascertained by Capt. Parsons, viz.:

Surface, Max. 79° Fah., at 1,030 fathoms, Min. 38°
" 82° " " 1,060 " " 38°.5

Stated Meeting, March 17, 1871.

Present, seventeen members.

Dr. Wood, President, in the chair.

Photographs of Mr. Frederick Graff and Prof. D. F. Sandberger, of Würzburg, were received for the Album.

A letter of envoy was received from the Swedish Bureau of Statistics.

Letters of acknowledgment were received from Herr Haidinger, of Vienna (for Proc. No. 81, 82); Dr. D. F. Sandberger (81, 82, 83); Edinbourg Observatory (82); Prof. Bunsen (82, 83); Prof. Kirchhoff (82, 83); Smithsonian Institute and Essex Institute (85); Harrisburg State Library and Baltimore Peabody Institute (Proc. 85 and Trans. XIV.–III.); D. H. Storer, Yale College (85, XIV.-I.); West Point Academy Library

(85, XIV.–III.); N. Y. N. H. Lyceum, New York, New Jersey, and Massachusetts Historical Societies, Boston Public Library, and American Antiquarian Society (all for Trans. XIV.–I.).

An extract from a letter of Mr. Carlier to Mr. Durand, respecting the Michaux Legacy, was read.

Donations for the Library were received from the R. Prussian Academy, the Society at Leyden (Flora Batava), the Statistical Bureau of Sweden, the Museum of Com. Zool. of Harvard College, Prof. Mayer of S. Bethlehem, the College of Pharmacy, Medical News and Penn. Monthly, of Philadelphia, Mrs. M. E. Tyson, of Baltimore, the State Geologist of Illinois, the Minnesota Historical Society, and Mr. W. H. Jackson.

The death of Judge Conyngham, of Wilksbarre, Pa., a member of the Society, was announced by the Secretary, and on motion of Prof. Cresson, the Rev. Bishop Stevens was appointed to prepare an obituary notice of the deceased.

The death of Prof. Charles M. Wetherill, of Lehigh University, Pa., was announced by the Secretary, and on motion of Prof. Cresson, Prof. Frazer was appointed to prepare an obituary notice of the deceased.

Prof. Cope exhibited a suite of fossils obtained by further exploration of the Bone Cavern near Port Kennedy, and informed the members of the progress of the examination. A discussion ensued, in which Prof. Cope expressed his views of migration, considering that the higher types belonging to Eocene and Miocene ages (including the fresh water fishes, Idaho), being all Asiatic, show a land emigration over the space now occupied by the North Pacific Ocean. When this fauna was destroyed by cold, the sinking of the North Pacific area, and the ice barrier together prevented its restoration. It was, therefore, replaced by a fauna of a lower type from Central America.

Mr. Chase communicated his views of the anticyclonic character of our winds and periodic storms between the 25° and 46° N. Lat. parallels, and between the meridians of Passamaquoddy and 100° West.

Pending nominations Nos. 669, 670, and new nominations Nos. 671, 672, 673, 674, were read.

And the meeting was adjourned.

Winds of the *United States.*

By Pliny Earle Chase.

(*Read before the American Philosophical Society, March* 17, 1871.)

Notwithstanding Ferrel's mathematical, and Galton's practical, demonstration of the tendency, in winds of propulsion, to become anti-cyclonic, many meteorologists regard cyclonic atmospheric currents as normal, in fair as well as in stormy weather. Such an impression may be naturally strengthened by the admitted facts, that most of the European winds are cyclonic, that all currents flowing in towards a centre of low pressure, speedily become cyclonic, and that the system of aspiration induced by the diminished pressure at the equator, is the proximate cause of all our atmospheric circulation.

But it should be remembered on the other hand, that the normal motion of the principal oceanic, atmospheric and magnetic currents, both polar and equatorial, and the daily veering of the wind consequent on the progressive heating of the earth's surface, are confessedly anti-cyclonic; that centres of violent and rapid commotion must necessarily cover a smaller area than the less disturbed peripheries which help to restore the equilibrium; that the air drifts more often in alternate ridges and troughs than in spirals; and that downward pressure is the impelling force by which the partial vacua, produced by increase of temperature or by condensation of vapor, are supplied. Each of these considerations is indicative of systems of winds over the entire globe, which are normally anti-cyclonic, and only exceptionally cyclonic. Even in storms, the blending of opposite currents may take place at a circumference as well as at a centre, and condensation of vapor may be going on along an extended line, the equilibrium being restored by the pressure of an adjacent ridge, as well as over a limited area towards which there is an influx from all quarters. There may, therefore, be anti-cyclonic as well as cyclonic storms. In fact, as I stated at the last meeting of the Society, most of our recent storms have been of the former character, and the more closely I have scrutinized the Signal Service observations, the more strongly have I been impressed with the belief that most, if not all, of our north-easterly storms are anti-cyclonic as a whole, though they may be accompanied by limited and comparatively insignificant local cyclones, and although, in consequence of the trend of our Atlantic coast and the in-draught towards the gulf stream, they may assume a form more or less cyclonic as they leave our shores.

The charts in Coffin's Winds of the Northern Hemisphere, seem to me to furnish ample confirmation to these views, although, in consequence of their very admirable fulness of detail, general tendencies are sometimes disguised by the local deflecting influences of mountains, lakes and valleys. In order to eliminate such local disturbances, I have grouped by States and Territories, all the winds in the first volume of the "Results of Meteorological Observations," from 1854 to 1859 inclusive, and computed the resultant for the entire period for each district.

I. Number of Winds from each cardinal point.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
British America	1651	3509	853	2645	2098	4735	3055	4932
Maine	2008	4331	1198	2664	2248	6349	3324	8342
New Hampshire	860	1464	1234	1607	933	2652	3057	4641
Vermont	3585	761	401	1150	6225	2018	1976	4040
Massachusetts	3681	7158	2619	6068	3802	13656	8020	18095
Rhode Island	133	518	73	120	241	720	199	1114
Connecticut	1560	2636	675	1569	1842	4352	1498	5940
New York	4639	6581	3692	6582	8676	14314	14882	13342
New Jersey	1016	2590	658	1423	1056	4158	2377	3989
Pennsylvania	4556	6399	6743	6848	6398	13617	17346	16930
Delaware	39	147	59	90	42	164	97	316
Maryland & D. of C.	1650	2849	1082	1674	2621	3812	4410	3870
Virginia	3725	3230	1759	1790	4590	5616	3400	4319
North Carolina	1019	1760	470	512	809	2019	2080	1122
South Carolina	1248	3252	1036	2026	1505	3989	1616	2306
Georgia	1585	3436	2052	2595	2415	3240	2611	4118
Florida	2374	6455	2651	3831	1411	4265	1801	3141
Alabama	676	508	548	1307	734	859	897	1096
Mississippi	923	929	738	1211	971	1253	812	1447
Louisiana	736	969	194	1040	793	782	134	659
Texas	4357	1011	1168	2966	5871	1510	1009	1181
Tennessee	567	649	316	884	980	755	393	715
Kentucky	604	1343	447	762	1218	3159	1453	1650
Ohio	3151	5277	1976	6509	4742	14747	7449	9828
Michigan	2079	3508	2776	3427	3061	7300	6170	5608
Indiana	1449	1086	990	1853	1910	2901	2591	2418
Illinois	3510	7151	3593	6963	8026	11218	8063	9126
Missouri	531	492	678	1195	906	838	1081	710
Wisconsin	3321	4932	2689	4073	4150	6967	5374	5906
Iowa	2249	3144	1636	5370	3648	5891	3063	7374
Minnesota	915	753	910	782	1469	710	1209	2033
Nebraska	1035	436	235	598	1226	434	287	717
Kansas	984	491	360	757	1371	559	182	586
Mexico	172	345	73	59	68	144	85	123
California	985	235	185	904	1272	1175	979	904
Bahamas	163	348	252	292	217	418	200	182
Guatemala	56	806	18	16	3	262	6	52
Surinam	89	803	417	427	141	39	5	19

II. Percentages, and Resultant Winds.

	N.	N E.	E.	S.E.	S.	S.W.	W.	N.W.	Resultant.
British America	7	15	4	11	9	20	13	21	N. 85°28'W.
Maine	7	14	4	9	7	21	11	27	" 72 47 "
New Hampshire	5	9	7	10	6	16	19	28	" 75 39 "
Vermont	17	4	2	6	31	10	10	20	S. 71 46 "
Massachusetts	6	11	4	9	6	22	13	29	N. 78 26 "
Rhode Island	4	17	2	4	8	23	6	36	" 65 4 "
Connecticut	8	13	3	8	9	22	7	30	" 72 43 "
New York	6	9	5	9	12	20	21	18	S. 77 34 "
New Jersey	6	15	4	8	6	24	14	23	N. 81 45 "
Pennsylvania	6	8	9	9	8	17	22	21	" 89 20 "
Delaware	4	16	6	9	5	17	10	33	" 55 23 "
Maryland & D. of C.	7	13	5	8	12	17	20	18	S. 88 59 "
Virginia	13	12	6	6	16	20	12	15	" 81 31 "
North Carolina	10	18	5	5	8	21	21	12	N. 78 22 "
South Carolina	7	19	6	12	9	23	10	14	S. 65 57 "
Georgia	7	15	9	12	11	15	12	19	N. 74 59 "

Florida	9	25	10	15	5	16	7	13	N	50	7 E.
Alabama	10	8	8	20	11	13	14	16	S.	44	25 W
Mississippi	11	11	9	15	12	15	10	17	"	76	48 "
Louisiana	14	18	4	20	15	15	2	12	"	67	10 E.
Texas	23	5	6	16	31	8	5	6	"	13	28 "
Tennessee	11	12	6	17	19	14	7	14	"	8	57 W.
Kentucky	6	13	4	7	11	30	14	15	"	67	53 "
Ohio	6	10	4	12	9	27	14	18	"	67	45 "
Michigan	6	10	8	10	9	22	18	17	"	74	26 "
Indiana	9	7	7	12	13	19	17	16	"	67	40 "
Illinois	6	12	6	12	14	20	14	16	"	52	18 "
Missouri	8	8	10	19	14	13	17	11	"	17	34 "
Wisconsin	9	13	7	11	11	19	14	16	"	79	50 "
Iowa	7	10	5	17	11	18	9	23	"	68	6 "
Minnesota	10	9	10	9	17	8	14	23	N.	82	39 "
Nebraska	21	9	5	12	25	8	6	14	S.	50	4 "
Kansas	19	9	7	14	26	11	3	11	"	24	18 E.
Mexico	16	32	7	6	6	13	8	12	N.	16	15 "
California	15	3	3	14	19	18	15	13	S.	56	53 W.
Bahamas	8	17	12	14	10	20	10	9	"	23	53 E.
Guatemala	5	66	2	1	0	21	1	4	N.	43	17 "
Surinam	5	41	22	22	7	2	0	1	"	80	53 "

This grouping, by exhibiting the excess or deficiency, in the percentage of any given wind, from the percentage of the same wind in adjacent districts, shows local irregularities which are often easily explicable by the physical features of the neighborhood, and enables us, by plotting the general resultants on a map, to demonstrate the anti-cyclonic motion of the air, over the entire region between the twenty-fifth and forty-fifth parallel of latitude, and between Passamaquoddy Bay on the east, and the 100th meridian on the west. It shows, moreover, that there is a normal intersection of a polar (N. E.) current off the coast of Florida, with an equatorial (S. W.) current from the Bahama Islands, and a similar intersection of a south-easterly and south-westerly equatorial current, (the latter having been refrigerated by the Sierra Nevada,) near the common boundary line of Nebraska and Kansas. The former of these intersections is analogous to the one referred to by Mr. Scott, as indicative of an approaching gale in the British Islands, and suggests an obvious explanation of the gulf stream cyclones, as well as of the cyclonic winds in Western Europe; the latter helps to account for a considerable proportion of our land storms.

The comparison of these currents and intersections with Blodget's hyetal charts is very instructive, and I feel little hesitation in predicting that a more thorough acquaintance with the winds of Alaska and British America, will develop another anti-cyclonic system, referable to a different centre of disturbance, with intersecting normals near the northern boundary line between the polar and equatorial prevailing winds, and perhaps in the valley of the Saskatchewan, which has been specially designated by Professor Henry as a storm-breeding district.

Resemblance of *Atmospheric, Magnetic and Oceanic Currents.*

By Pliny Earle Chase.

(*Read before the American Philosophical Society, April* 7, 1871.)

My belief that terrestial magnetism is dependent solely upon fluid currents, electrified by convection and by the condensation of vapor, led me to look for some confirmation of my views in the results of my recent discussions of the winds of the United States. My attention was first drawn to the resemblance between the looped isogonic lines in the eastern equatorial portion of the Pacific Ocean, and the anti-cyclonic course of the winds in the Gulf States. The undoubted rapidity of magnetic action, a rapidity analogous to, if not identical with, that of luminiferous vibrations, renders it probable that the flexure of the isogonic lines, at any given point, may be determined by the resultant of all the forces acting at that point, and that the equatorial loops are, therefore, expressions of equatorial disturbance.

If the same disturbance is communicated to the more sluggish air, its culmination may naturally be sought at some point northward and eastward, because of the well-known laws of current deflection. The principal thermal contrasts which contribute to the establishment of currents, are: 1st, land and water; 2d, polar and equatorial; 3d, heat and cold at isabnormal centres. It seems reasonable to suppose that these triple contrasts should be so mutually related, that there may be some system of rectangular coördinate planes which would present each of them as a maximum.

A great circle cutting the equator on the meridians of 100° W. and 80° E., and passing through the geographic centre of the land hemisphere, follows the general trend of the American coast from Florida to Newfoundland, skirts the equatorial isogonic and the Florida atmospheric loops, finds the western limit of our anti-cyclonic system of winds at a point about midway between the magnetic pole and the equator, and crosses the equator on the meridians and near the centres of greatest Horizontal Force. A co-ordinate great circle following the meridians of 10° W. and 170° E., intersects the magnetic equator of minimum intensity near its greatest northern and southern elongations. The third co-ordinate great circle corresponds very nearly with the dividing plane between the land and water hemispheres. The principal north pole of declination and the Asiatic equatorial intersection of the line of no variation, are on the meridians first named, which traverse the intersections of the first and third co-ordinate circles. A great circle intersecting the second co-ordinate on the equator, and passing near the North American pole of declination, would cut the first of these meridians (100° W.) at an angular distance from the pole analogous to that of the Florida wind loop from the equator, traversing the principal isogonic loops in such manner as to exhibit the magnetic symmetry of the entire globe to the best advantage. No other system of rectangular co-ordinate planes would meet with so little land interruption, or would divide the globe into hemispheres with so great current-producing contrasts.

An observer, therefore, near the centre of the land hemisphere, would find, at the four cardinal points of his true horizon, magnetic, thermal and geographic positions of peculiar importance, and indicative of interesting mutual relations. The recognition of such relations gives a new interest to the often noticed resemblance between the isoclinal and isothermal lines, the analogy which I have myself pointed out between the isogonic and cotidal lines, the parallelism of the boundary lines and of the axis of the westerly isogonic belt with the boundaries of the corresponding annual isabnormal belt, the isogonic curvatures in or about regions of isabnormal heat or cold, the different angular relations of the isogonic lines to the customary paths of hurricanes and storms, and the approximate perpendicularity of direction and opposition of curvature between the westerly wind belt and the isogons. All of these features, which may be satisfactorily explained by the general principles on which storm laws are based, furnish cumulative, if not irresistible, evidence of the dependence of magnetic currents upon the same laws of gravitation, which tend to restore the equilibrium of air and sea, after tidal or thermal disturbances. The evidence is sustained not only in the general distribution of the magnetic lines, but also in their particular details, the course of the isogonic lines, *at every point*, being an evident resultant of the combined equilibrating tendencies between land and water, and between centres of normal and isabnormal heat and cold.

The ocean currents corroborate the gravitation theory of magnetism, perhaps even more strongly than the wind belt. A physical atlas like Petermann's, which marks the most rapid portions of the several currents with the deepest tints, shows their relation to the magnetic and coast lines very satisfactorily. A comparison of the more minute details exhibits additional interesting evidence that the original impulse of all terrestial currents, atmospheric, magnetic and oceanic, is given by luminous, thermal or tidal disturbances, that the currents are maintained by gravity in its continual tendencies to restore the continually disturbed equilibrium, that the magnetic currents are least, while the ocean currents are most interrupted and modified by land contours, that each of the more sluggish currents exerts a secondary modifying influence on the more rapid, that extraordinary variations in thermal or luminous undulations, whether originating at the sun or at the earth, produce "magnetic storms," and that, whatever theory may be adopted as to the mode in which the solar undulations are transmitted, there is no philosophical necessity for the hypothesis of any cosmical origin or disturbance of terrestrial magnetism other than variations in the amount of light and heat received and in the directions of gravitating tidal and equilibrating lines.*

* It is so difficult to make the necessary allowances for the distortions of the ordinary magnetic charts, that I would recommend any one, who may desire to make the comparisons which I have suggested, to trace the lines on a globe. A slate globe is especially satisfactory. The data for my own comparisons were taken from the lines of equal magnetic variation and of equal horizontal force for 1860, in the 2d edition of the "Admiralty Manual for ascertaining and applying the deviations of a compass, caused by the iron in a ship." Walker's "Terrestial and Cosmical Magnetism;" Coffin's "Winds of the Northern Hemisphere;" Dove's "Isothermal and Isabnormal charts," "Petermann's and Johnston's Physical Atlases." In order to judge of the resultant influences of the normal and isabnormal thermal disturbances, it will be well to mark the *centres* of isabnormal heat and cold, as well as the points of greatest average heat and cold.

Mr. Walker, in his Adams Prize Essay for 1865, p. 268, says: "it is worthy of remark that the portion of the year when the magnetic force is the greatest, and the direction of the needle most vertical in *both* hemispheres, coincides with that at which the earth is nearest to the sun and moves with the greatest velocity in its orbit. This fact furnishes another argument against the theory that these effects are due to *temperature*, as in that case they ought to occur at *opposite* periods of the year in the two hemispheres, whereas in fact they occur at the same period in both." The writer was doubtless misled by the annual variations in declination and horizontal force, which are evidently dependent upon the relative temperature of the northern and southern hemispheres. But if all the magnetic effects are primarily due to thermal and gravitating motion, it is evident that the *total* magnetic force must depend upon the *total* current producing energy of the sun, which is, of course, a maximum when "the earth is nearest the sun, and moves with the greatest velocity in its orbit." The argument which was considered conclusive against the theory, is, therefore, wholly in its favor.

THE CAUSES OF *Regional Elevations and Subsidences*, by LIEUT. C. E. DUTTON.

(*Read before the American Philosophical Society, April* 7, 1871.)

Lieut. C. E. Dutton, desired to submit certain views, which he had been led to entertain, respecting the causes of regional elevations and subsidences. He was unacquainted with any views on this subject in the writings of geologists, which seemed to be satisfactory. In reflecting upon the nature of metamorphic rocks, and the probable changes which they had undergone, he thought that the facts brought to light by the researches of Bischoff, Daubrée, Sorby, Sterry-Hunt and others in that field, might contain, also, a solution of the unexplained problem of elevations and subsidences. It is now a generally accepted opinion among writers upon chemical geology, that metamorphic rocks have reached their present condition, through the combined agencies of heat, pressure, and water, acting upon sedimentary strata; that sulphur, carbonic acid and volatile chlorides and fluorides have played highly important parts under similar conditions, and that soluble earths and metallic salts and vapors have had no inconsiderable influence upon the totality of changes. That water especially, under the influence of a moderately high temperature and great pressure, is capable of changing in a wonderful manner the structure and arrangement of rocky materials of all kinds, has been abundantly shown by innumerable synthetical experiments, a great number of which have been summed up by Daubrée in an able memoir on the subject to the French Academy. He has also shown that minerals, which,

under ordinary temperatures to which water is subjected, are in no respect changed, may be completely altered by water confined in strong vessels and heated to dull redness. Silicates, aluminates and calcareous matters in the amorphous condition, may not only be made crystalline, but their degrees of hydration may also be permanently altered; and he also mentions the production of anthracite by a similar process, from wood. Indeed, the changes both of structure and chemical constitution, which may be produced in this manner, are very great, and extend, in all probability, to nearly the whole range of mineral matters found in the rocks.

Now, if as is generally believed and accepted, these are the changes in progress, while rocks are undergoing metamorphism, then, in all probability, the rocks are undergoing at the same time *a change in their specific gravity*. It is highly probable, if water is the chief reagent, and if it constitutes a change both chemical and physical, that the specific gravity of the mass, into which it enters, is not the same as it was before such a change took place. But if we admit this, then we have also admitted that the volume of those rocks has either increased or diminished. If we assume it to have increased, there must take place an expansion, and such an expansion must necessarily be upward. For, beginning at the lowest level, at which any such change may be assumed to supervene, the total weight of the superincumbent mass is the same as it was before, and hence there would be no change at that level. Nor could there be lateral expansion of any importance; all expansion would of necessity be vertically upwards. On the other hand, a decrease of volume would occasion a subsidence for converse reasons.

If we were to assume a change in the specific gravity of 1000 feet of rock, to the extent of five per cent., we could account for a change of level of 50 feet, and a series of rocks as thick as the carboniferous in this State, would, with an equal amount of change, give an alteration of level equal to the average attitude of the North American Continent above the ocean. It is, of course, impossible to conjecture the depth to which metamorphic action may extend, though it is undoubtedly very great; at least eight or ten miles, and there might be no great improbability in supposing such changes to take place through a large portion of that depth at the same time.

That the rocks far down below the surface take up under the influence of great pressure, aided no doubt by heat, large quantities of water, carbonic acid, sulphydric acid, and perhaps other electro-negative agents, is manifest in the materials issuing from volcanoes and from thermal springs. Water and gaseous acids issue in such enormous quantities from volcanoes, as to constitute a large fraction of the entire mass delivered, indicating that the solid materials have become super-saturated with them, and the association is resolved as soon as they reach the surface of the earth, and are relieved of the pressure to which they have been subjected.

The overflow of volcanoes would, it is suggested, be susceptible of a similar explanation. Let us suppose a stratum or two, situated a few miles

below the surface, became softened or lightened by the combined agencies described, so as to be specifically lighter than the average mass of overlaying rock. If a vent or fissure could be found, such a plastic mass would inevitably follow the laws of the equilibrium of fluids, and would not only rise up into the chasm, but overflow. Putting the problem into another form, the heavier over-lying mass would sink into the lighter semi-fluid beneath, and drive it upwards. It is a well known fact, that the lavas are all of small specific gravity. Indeed, were it otherwise, Lieut. Dutton thought that the overflow of a lofty volcano like Ætna or Mauna Loa, would be impossible; for a column of dense material of such a height, exerting its pressure upon its subterranean reservoir, would raise the overlying strata, instead of rising above them. But, in truth, the superior strata are doubtless heavier, and exert a greater pressure upon the reservoir than the lava itself.

In a similar manner Lieut. Dutton sought to explain the intrusion of traps, trachytes and basalts. These rocks were probably lighter than those which originally overlaid them, and forced their way through weak places to the surface. The traps, basalts and porphyries,—at least such porphyries as may be called intrusive—though they are unquestionably altered sediments, are for the most part amorphous, and not crystalline. They were evidently altered at a comparatively low temperature, and at no very great depth. They do not appear to affect the strata into which they are intruded, and withal, are less highly metamorphic than gneiss or marble. Water seems to have been the chief agent in their transformation, and they may have been forced upward in a soft condition, and upon being relieved of the pressure, parted with the greater portion of this water. The traps and basalts also exhibit many planes of cleavage, with very perceptible interstices, and these interstices would seem to be much wider than could be accounted for by the contraction of cooling. He stated that he had often noted this fact, and was decidedly of the opinion that the contraction of these rocks by loss of heat, could by no means account for the entire width of such plans of cleavage, and believed that it was in great part due to the loss of water, which had once rendered them plastic.

If these views be correct, then we ought to expect that volcanic regions will be confined to those areas which have recently been regions of marked elevation. And we find this to be the case. In America, the whole extent of the Rocky Mountains and of the Andes, so far as known, was covered by the ocean at the beginning of the Tertiary period. The elevation of the Rocky Mountains was probably earlier than that of the Andes, and sooner completed. Hence, while the former was the scene of an unparalleled amount of volcanic action during the Pliocene and Miocene, and is now nearly, or quite, quiescent, except in Southern Mexico, the Andes still abound in active volcanoes. The East Indian volcanic regions are all of Tertiary formation, as are those of the Mediterranean and the Auvergne.

PRELIMINARY REPORT ON THE VERTEBRATA DISCOVERED IN THE PORT KENNEDY BONE CAVE.

By Prof. E. D. Cope.

(*Read before the American Philosophical Society April* 7, 1871.)

My friend, Charles M. Wheatley, has already given an account of the discovery of a fissure in the Potsdam limestone of Chester Co., Pennsylvania, containing the remains of numerous animals and plants of the Postpliocene period (see Amer. Jour. Sci. Arts, 1871, April). Dr. Quick, of Phœnixville, having brought to his notice mastodon remains exposed in quarrying the limestone near Port Kennedy, he visited the spot, and determined the existence of the fissure and its contents. In the article in question he describes it as situated near the line of junction of the Triassic red sandstone. Its depth is nearly fifty feet, and the greatest width thirty; at the summit or surface of the limestone, its width is twenty feet. It is filled to a depth of forty feet with the debris of the neighboring Triassic strata, of a red color; below this point is a bed of tough "black clay eighteen inches in thickness, filled with leaves, stems, and seed vessels of post-tertiary plants. Scattered through all this mass of vegetable remains, and also in a red tough clay underneath for six to eight inches in depth, are found the fossils noticed in this paper."

Mr. Wheatley furnishes a list of the species we had identified up to the time of writing, viz.; twenty-seven vertebrata, ten coleoptera, and ten plants. These numbers have been considerably increased up to the present time, and I look to a much fuller and more complete exposition of the Postpliocene vertebrate fauna, in consequence of a more thorough examination of the remaining part of the fissure, by my friend, C. M. Wheatley.

As regards the position of the remains, the article above quoted, proceeds to state that "the remains of Mylodon, Ursus, and Tapirus have been mostly obtained from the tough red clay directly under the plant bed, but the remains of rodents, snakes, tortoises, plants, and insects, are entirely confined to the plant bed. Neither the bones nor the teeth are rolled or water worn, but all are sharp and well defined." The appearance of the specimens corroborates the above statements. I would add some exceptions. Thus two of the specimens referred to *Arvicola sigmodus* came from the red bed, and one from the black; one *Megalonyx wheatleyi*, came from the black bed, the others from the red. Milk teeth of Mastodon occur in the red bed also. General remarks are deferred to the close of the report.

Megalonyx, Jefferson.

The remains of species of this genus found in the fissure are more abundant and striking than those of any other. At least fourteen individuals are represented by the bones and teeth obtained. These belong probably to five species, as described below, four of them different from

those hitherto known, three of them of a size equal to that of the *M. jeffersonii*, the others smaller. These species are only certainly distinguishable at present by the teeth, as the other bones are very similar to those of other species, so far as preserved.

The teeth consist of eighteen canine, and nineteen molar teeth, whose characters are discussed below. The bones are chiefly those of the feet, with portions of long bones, and numerous vertebræ. Cranial bones are in most instances destroyed, for though several complete crania were exhumed, the exposure to frosts and thaws with snow and rain, as they laid in the piles of material, disintegrated them. Of limb bones there are the extremity of a large tibia with cotylus for astragalus, several extremities of fibulæ, and some broken heads of femora.

Of the bones of the fore limb there are three unciforms, two magnums, and fifteen metacarpals with numerous phalanges. The bones of the hind limb include three astragali, seven cubiods, six scaphoids, and five incomplete metatarsals. The phalanges of both fore and hind feet, which much resemble each other, number thirty-two, of which nine are ungueal. Of vertebræ, no cervicals have been found, except an axis without neural arch. Caudals are most numerous; some of the vertebræ have coössified epiphyses, others not, indicating various ages. I have counted twelve individuals from the teeth, but it is quite possible that there are others represented by some of the bones.

The canine (molar) teeth present a remarkable variety of forms. As is known, the section of the crown is oval, on one side concave with a more or less prominent swelling interrupting it. The differences are seen in the development and position of the broad rib of which the swelling is a section, in the curvature of the shaft, and greater or less obliquity of the grinding surface.

There are three types of form among them as follows:

1st. The shaft curved, the triturating surface oblique, the internal longitudinal rib prominent, nearer one end of the crown than the other, dentine of inner side thickened anteriorly; two specimens.

2d. Shaft nearly straight, triturating surface transverse (in its long direction); rib of inner face median, prominent; dentine of inner side uniformly thin.

3d. As in the last, but the shaft more compressed, therefore the section narrower, the inner bulging rib being very low and insignificant.

The first of these represents a species distinct from those of the other series; one nearer the *M. jeffersonii*, and of large size.

In studying the present genus I have been under many obligations to Dr. Leidy's Memoir on the Extinct Sloth tribe of North America, published by the Smithonian Institute in 1855. In it the species *Megalonyx jeffersonii* is established for the first time on a solid foundation, and the characters, especially of the dentition, clearly pointed out.

Megalonyx loxodon, Cope, species nova.

The two teeth of the first type may, perhaps, be superior ones; their curvature accounts for the obliquity of the grinding face in the long

direction. This curvature is seen in teeth of *M. jeffersonii* (See Leidy's Memoir on Extinct Sloth tribe, Pl. VI., figs. 4-6), which do not appear to be straight in the maxillary bone at least, at any time. These teeth differ from those of *M. jeffersonii* in having the posterior margin thinned out, while the anterior is thickened by the near aproximation of the interior rib. In the larger of the two the posterior margin is slightly incurved, the exterior convexity thus produced opposing that of the anterior face and inner rib, as one short side of a romboid does that opposite to it. The section of the smaller differs in the shortness of this intero-external face, and is thus rounded subtriangularly and antero-internally, as described by Leidy in the *M. jeffersonii*, and thus different from that seen in the *M. wheatleyi*. The external face has an open longitudinal concavity, The triturating surface in both teeth is a longitudinal groove; in the larger, the inner margin is highest anteriorly, the outer highest posteriorly.

These teeth I suppose to represent a species different from the *M. wheatleyi*, and perhaps from the *M. jeffersonii* also, as none of the sections given by Leidy (l. c. Pl. XVI), approach their form. The nearest is his fig. 3, where the section of the bulge is not quite central.

MEGALONYX WHEATLEYI, Cope.

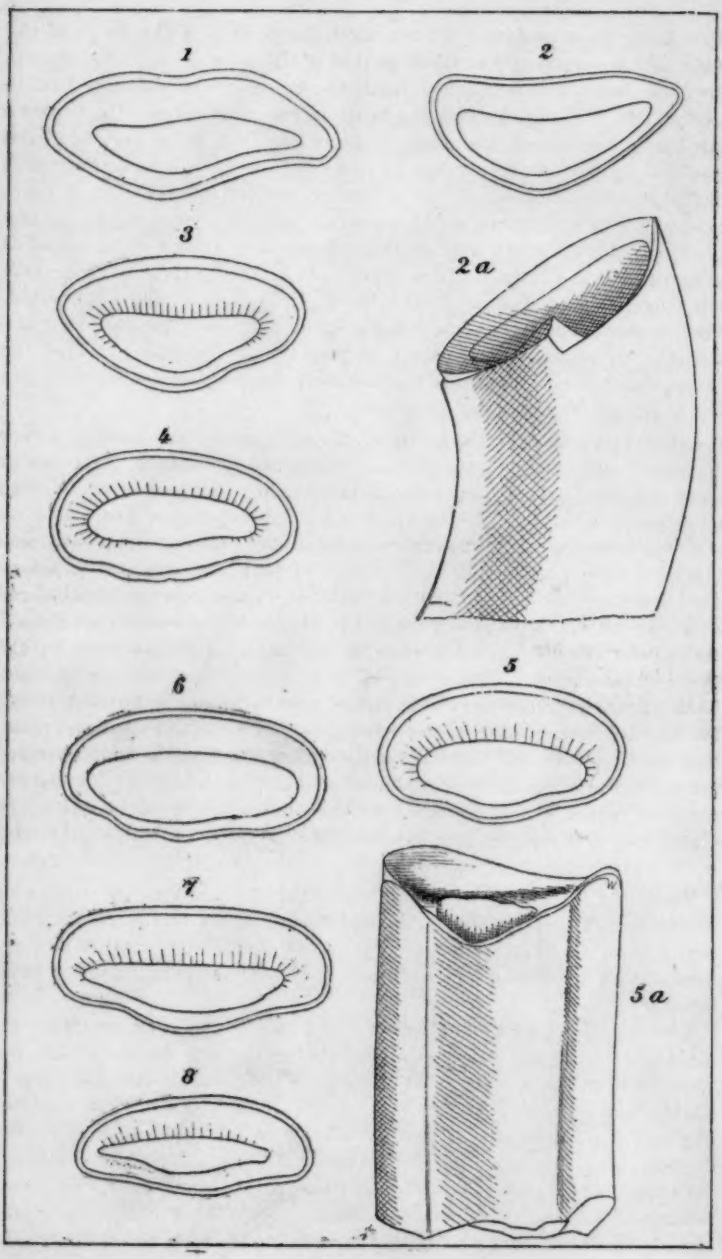
Species nova.

Represented especially by fourteen canine and sixteen molar teeth, but probably also by the greater part of the bones above mentioned. The former are referable to eight individuals, to which perhaps four others should be added.

The characters of the species are chiefly visible in the molar teeth, which in the maxillary bone are acutely trigonal instead of triangular ovate as in the *M. jeffersonii*; and in the dentary bone, transversely, sometimes narrowly, parallelogrammic, frequently narrower internally than externally. In the *M. jeffersonii* the latter are almost as broad as long, of equal width, and with the inner or outer margin slightly oblique.

In the *canine-molars* before mentioned of the second and third types, we have but little or no curvature of the shaft, no longitudinal grooving of the outer face, the outer dentinal wall uniformly higher on the triturating surface than the inner, and the long diameter of this face but little oblique to the transverse plane of the shaft. As both superior and inferior molars corresponding in size, color, and number to these teeth have been found, I suppose the latter to have been derived from both jaws.

The differences in these teeth are to be seen in the different degrees of development of the dentine layer, and of the bulge on the inner face, and of the degree of compression of the shaft. Five of the best preserved exhibit the thickness of the external layer continued round the extremities of the grinding surface, and then rather abruptly contracting wedge like, into the thin layer of the interior face. In two other teeth this contraction takes place at the external curves, and is less in degree, the inner


1
2
3
2a
4
6
5
7
5a
8

layer being more uniform. In two teeth the dentine of the bulge of the inner face is very nearly as thick as that of the outer (F. 4). As regards the form, in the last mentioned tooth the bulge is well developed (as in Leidy's Pl. XVI. fig. 1), and the shaft is not compressed. In the two previously mentioned, the shaft is short and the bulge very low and bounded by two shallow grooves; in one (F. 6) (which is accompanied by the posterior molars), it has a shallow median groove. In the five canine molars first named we have every degree of compression. In one (F. 3) the shaft is stout, and the bulge larger than in any other, about as in Leidy's Pl. XVI. fig. 2; in a second (F. 5) the shaft is similar, with low bulge, like fig. 7. l. c. In the third (F. 7) from a large individual, there is more compression, and the bulge is very low; the last two are similar, but smaller; they belong apparently to opposite sides of the same animal (F.8). These are like the tooth figured and described by Dr. Leidy as that of *Megalonyx dissimilis*.

I am inclined to refer the teeth of these types to one species, a view confirmed by a study of the molars. They are all stained yellowish or light rust color except one, which is black, and which is associated with three posterior molars of similar color and corresponding size. The remaining posterior molars are of the color of the other canine molars, and no doubt belong to the same individuals in part, but none can be associated with the same certainty as the black specimens. On the light colored posterior molars I propose to establish the *Megalonyx wheatleyi*, since I should scarcely distinguish it from *M. jeffersonii*, or *M. dissimilis* by the canine-molars alone. There can be no question that the forms of these teeth, characteristic of the two supposed species, graduate into each other; the characters derived from the development of the interior enamel plate, may be distinctive, but in that case there is at least one other undescribed species in the series I have explained above. *M. dissimilis* it appears to me must repose on the posterior upper molar, which Leidy shows to be transversly oval and not triangular in section. That tooth is as triangular in *M. wheatleyi* as in *M. jeffersonii*.

From the preceding, it is probable that the most allied species of *Megalonyx*, cannot be exactly defined by the characters of their canine molar teeth, though, as in many species of Mammalia, they may be indicated by the extreme forms of those teeth, the range of variation overlapping.

The *superior-molars* (1a) belong to at least three (perhaps four) individuals. They are nearly straight trilateral prisms, so worn that the inner anterior angle is the most elevated. The anterior dentinal plane is slightly convex, the posterior concave to a less degree. The exterior angle is much less obtuse than in *M. jeffersonii*, that enclosed by the dentine being prolonged and very narrow. There is a notable difference between the two posterior molars of the superior series, preserved. One belongs to the individual stained black. Both are slightly bowed posteriorly, and both have a subtriangular section, the apex directed inwards.

In the light colored specimen the outer face is wide and nearly plane, the anterior very slightly convex, and the posterior concave, making an open longitudinal groove; the external angle is obtuse. In the black specimen the inner face is narrower, the anterior more distinctly convex, and the posterior convex also, rounding off to the more obtuse external angle. Both these teeth are worn obliquely as in *M. jeffersonii*.

The wearing of the median molars is transverse to the axis of the shaft anteriorly, oblique to it or descending inwards, posteriorly. The wearing in the long axis of the jaw bone, is obliquely forwards on the posterior dentinal wall, and divided on the anterior, one half sloping forwards and the other backwards, the slopes separated by a sharp ridge of the dentine.

A single tooth, which by its form is excluded from a place in the mandible, and by the character of the wearing of its crown, can be none other than the second molar, or first of the regular series. Its form is very different from that of the same tooth in *M. jeffersonii*, but is appropriate to the modification described below as characteristic of the inferior molars of *M. wheatleyi*. There is no anterior wear on the anterior dentinal plate, indicating the absence of any tooth anterior to it in the inferior jaw; this plate is much higher than the posterior, which has two worn surfaces, the anterior horizontal, the posterior oblique. The middle of the crown is concave, and the concavity is carried across the dentine of one end. The tooth is in section a transverse parallelogram with the outer short side oblique, instead of parallel to the inner. Anterior face slightly concave, posterior slightly convex.

The characters of the *inferior molars* are established by three posterior in place in the fragments of jaw held together by the matrix of red sand and clay. That they might be the superior series of another species is suggested by the subtriangular outline of two of them, and the jaw is so fragmentary that it is not sufficient to decide the case. The following points, however, are conclusive. If they were superior, the terminal teeth must be either the second or fifth molars, according to the relation to front or back in which they are viewed. That neither can occupy this place is proven by the following description:

The anterior is a rather narrow transverse parallelogram, with the sides and angles rounded. The posterior dentinal plate is worn transversely, the opposite one is oblique, descending to one side. The form is worn obliquely away from the centre of the crown, the latter is plane. The next tooth is a parallelogram narrowed towards one end, which is rounded obliquely to the other sides; it is narrower than the last, and the dentinal plates are worn in exactly the same way. The last tooth is much wider than the others, and has a subtriangular outline, the narrow end very wide and obtuse, and on the same side as the narrowed end of the one in front of it. The outline is worn in the same manner, except that the angle at one end of the base of the triangle is, perhaps, more elevated.

(1.) Neither of the extremital teeth have the oblique face of the pos-

terior one of the known species of *Megalonyx*, nor the reduced size, so that it remains to ascertain whether either of them is the first superior molar. (2.) The larger is evidently not so, because it has an obliquely-worn distal face, indicating the existence of another tooth beyond it in the opposite jaw. (3.) The opposite one is not the anterior molar, because (a) its anterior dentinal face is worn horizontally, not obliquely backward, indicating an overlapping tooth; (b) because the oblique wear of the dentine would, on the supposition that it is the first, be thrown on the posterior instead of the anterior faces of the other molars; (c) and because its form is narrower than the other teeth, instead of wider as in other species.

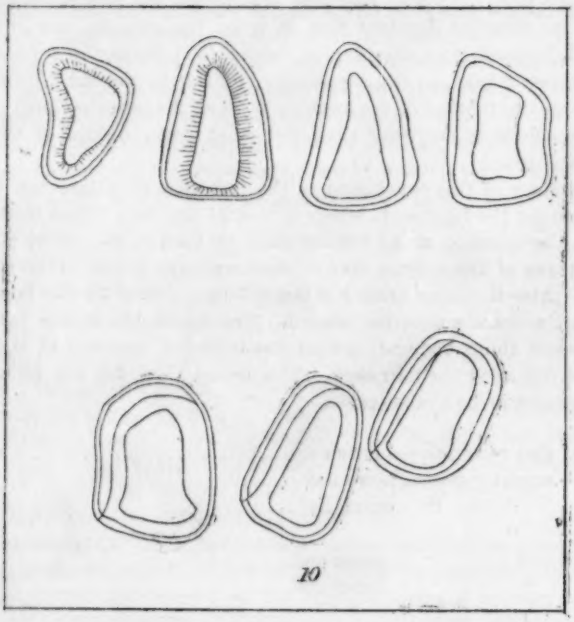
Confirmatory of this conclusion is the fact that no palate can be discovered among the fragments where it should be, were these teeth maxillaries. The question as to the relation of ends is settled by the fact that the plane of the crowns rises to the narrower, which would thus be anterior. Also the large tooth has the oblique surface for the last superior molar, which the anterior has not. The fragments of the jaw indicate the same thing, rising (towards the coronoid process) at the large tooth and falling at the narrower. The latter, then, for the above reasons, I assume to be the anterior.

	M.
Length of three juxtaposed crowns	0.053
" anterior crown, inner end	.013
" " " outer end	.013
Width " "	.02
Length of last " outer end	.014
" " " inner end	.0016
Width " "	.02
Length of shaft first tooth	.054

There are five isolated molars of the same type as the above. Three of these are evidently anterior or second inferior molars, two of the left side and one of the right. Their section is suboval, and all the details, size, &c., are as above described. Two others are like the second (or third) inferior molars. One of these is peculiar in being a little concave on the anterior face, the inner extremity very oblique, the other is more oval.

The question as to the *specific relations* of these inferior molars may be stated as follows. Their large size precludes the probability of their belonging to either *M. tortulus* or *M. sphenodon*. They appear to belong to one species, without doubt. The superior molars also belong to one species, and as no other species is represented in any thing like the same abundance, it is reasonable to suppose that these, with the most abundant of canine molars, belong to the same form of Megalonyx. The canine molars differ from those of *M. loxodon*, and the posterior upper molars from those of *M. dissimilis*. The disproportion between the sizes of the second and last inferior molars, with the narrow oval and triangu-

lar forms of the same, separates the animal from the *M. jeffersonii*. The only known molar of *M. validus*, Leidy, is like nothing found in the present species, and *M. rodens* and *M. meridionalis* each have their peculiar features. I therefore call the present animal *M. wheatleyi*.



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Another molar, perhaps the third inferior of the three, is larger, and appears to belong to another individual; it is a little wider inwardly, and resembles Leidy's fig. 13 of Pl. XVI., except in its narrower angle and perfect symmetry. It may belong to *M. wheatleyi*, but the outer angle is regularly rounded; it may be *M. sphenodon*. It differs from those of *M. jeffersonii* as the *M. wheatleyi*, in the greater extension in a transverse direction, and in the concavity of one of the long sides. The enclosed area of osteodentine is in section a frustrum of a narrow triangle, instead of rounded parallelogrammic as in *M. jeffersonii*.

Measurements of teeth.

					M.
Long diameter,	(Fig. 5)	light cold.	canine molar	.....	0.0316
Short	"	"	"	.....	.018
Long	" of (Fig. 3)	"	"	.....	.0325
Short	" "	"	"	.....	.019
Long	" of (Fig. 6)	black	"	.....	.035
Short	" "	"	"	.....	.017

Long diameter of	(Fig. 6)	black	super.	molar	.021
Short "	"	"	"		.015
Long "	(Fig. 9)	light,		"	.0215
Short "	"	"		"	.0158
Total length			"	"	.062
Long diameter 4	super.	molar	of	(Fig. 6)	.017
Short "	"		"		.011
Long "	"		(Fig. 9)		.018
Short "	"		"		.0129
Long "	inferior	molar	(light)		.0223
Short "	"		"		.015
Length "	2d	"	(loose)		.0214
Width "	"				.015

There are *vertebræ* of both adult and young animals. An axis is much like to that described by Leidy in *Megalonyx jeffersonii*. The centrum is much depressed, with a strong inferior keel. The articular faces of the lateral abutments and of the odontoid process are continuous. This process is short and conic, and is a continuation of a projection of the centrum, which is notched on each side above, at its anterior limit, for the annular ligament. A more posterior cervical, with coössified epiphyses, is much less depressed, and is about as broad as long. A caudal, with coössified epiphyses, has subround articular extremities, and is remarkable for the extent of the chevron articulation of both ends of the inferior aspect. These are connected by a lateral ridge which encloses a deep fossa.

Measurements of Vertebræ.

	M.
Length axis	0.089
Greatest width	.096
" neural canal	.035
Width centrum behind	.044
Depth " ??	.028
Length poster. cervical	.054
Width " articular face	.0565
Depth " "	.05
Lengh caudal	.052
Width " articular face	.057
Depth " "	.05
" " young, larger animal, with separate epiphyses	.083
" articular face, dorsal of young	.05
Width " "	.062
Length centrum of "	.0455

The *carpals* do not present marked difference when compared with those figured by Leidy under *M. jeffersonii*. Among the *tarsals*, one astragalus is exactly like that of the latter species; another is deeper and shorter, viewed from the inner side, with vertical truncation below in

front, and much deeper superior ligamentous pit. Of the scaphoids, two probably of the same animal, are deeper posteriorly, and with the convex part of the superior articular face rounded; four others are flatter, two with the articular face above rounded, and two subconical. The cuboids differ in the degrees of depression of form. Two are more depressed, three larger less so, and one still less.

The *metacarpals* are all present, and belong to several animals. There are four of the first, which appear to have belonged to two species. Three exhibit the articular extremity as very oblique to the superior plane of the bone, and including a groove between it and the surface of attachment to the 2d metacarpal. The inferior surface exhibits a swollen knob, and a pit behind it. The fourth is nearly plane above and below, with the articular ginglymus at right angles to both, and articulation to second metatarsal also at right angles to them. No groove between these surfaces, but a regular concavity. Outer extremity not projecting as in the first. The other metatarsals have the form and proportions already described by Leidy.

	M.
Length of Metatarsus I	.045
Width " posteriorly	.036
Length " II,	.059
Depth " "	.052
Length " III,	.0945
Depth " "	.057
Length " IV,	.104
Depth " "	.05

The phalanges are like those figured and described as belonging to the *M. jeffersonii*. Many of them are the proximal ones of greatly shortened proportions, characteristic of the sloths. The penultimate are of various sizes, an average one measures as follows:

	M.
Length	0.071
Depth behind	.045
Width "	.037

But the following measurements of a proximal phalange indicate an immensely large example.

	M.
Length	0.031
Depth behind	.062
Width "	.053

The *ungueal phalanges* are compressed and curved, with obtuse rounded superior margin. Only one exhibits a tendency to the acute superior margin characteristic of those typical of *M. jeffersonii*, though claws of both kinds have been ascribed to the latter. The inferior plane is gently convex. The insertion for flexor tendon is expanded laterally

over the origin of the nutritious foramen on each side, into a shelf: general form longitudinal oval. The superior direction of the median radius of the cotylus for the last phalange, shows that the claws were always flexed to some degree.

Fragments of many long bones, including many condyles, accompanied the above, but in the lack of certainty as to their proper reference, are not described.

This species is dedicated to Charles M. Wheatley, of Phœnixville, to whom Natural Science in the United States is under many obligations. The expense and much labor requisite for the proper recovery and elucidation of the remains contained in the cave are entirely due to his liberality and exertions. Similar devotion to Science has preserved to us the finest series of fossils of the triassic period of the Northern States in existence, and the finest collection of fresh water shells in America.

Megalonyx dissimilis, Leidy.

Proc. Acad. Nat. Sci., Phila., 1852, 117. Sloth tribe N. A., 45, Pl. xiv., figs. 4—8, xvi., 8 and 15.

Probably represented by three canine molars, which belong to at least two individuals. They have been described under head of the preceding species (see 1 a c). The canine molars are the only ones which can be compared with Leidy's figures and descriptions, with which they agree closely.

Measurements of teeth.

	M.
Long diam. canine molar, larger individual of 1 a c	0.036
Short " " " "	.0158
Long " " smaller "	.032
Short " " " "	.014
Length shaft " " "	.079

This species is evidently about the size of the *M. wheatleyi* and *M. jeffersonii*.

Megalonyx sphenodon, Cope.

This species is the smallest of the genus yet known from North America. It is indicated certainly by the canine-molars of opposite sides of one individual only.

These teeth are flat and a little curved. A principal peculiarity consists in the regular increase in their diameter, from the apex to the base, in both the longitudinal and the transverse directions. The long diameter of the triturating surface is four-fifths that of the base where broken off. The dentinal layer is thick externally; it contracts after turning, and the layer of the inner aspect is uniformally thin, but less so than in *M. dissimilis*. The inner bulge is well marked, and is a little nearer the anterior margin than the posterior; the latter is the thicker. The triturating surface is slightly oblique in the long direction, as in the two species

preceding this, and concave transversely ; the inner dentinal plate being worn much lower than the outer. Exterior face of tooth regularly and gently convex.

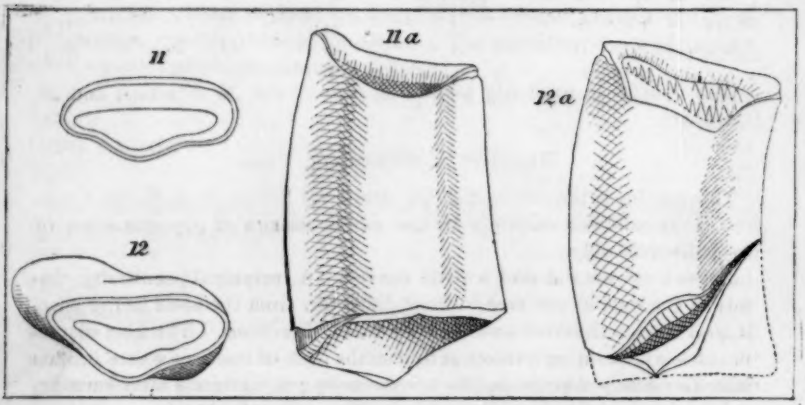
	M.
Length of fragment of tooth	0.044
Long diameter at grinding face	.025
" " " base fragment	.0275
Short " " " "	.0148
" " " grinding face	.0125

The question has naturally arisen, whether this tooth has not belonged to a young animal of *M. wheatleyi* or *M. jeffersonii*. Its small size and subconic form would suggest this view. Teeth of the monophyodont type, generally possess the character of those of the successional type, in being protruded of the full size, and not increasing in diameter with age. Exceptions, however, occur in some *Rodentia*, as the beaver. It has however, never been seen among the numerous teeth of sloths, which have been studied by authors, while a genus allied to *Mylodon*, *Sphenodon* of Lund, presents this character at maturity. Further, the most expanded portion of these teeth presents considerably smaller dimensions than the smallest of the *M. jeffersonii*, figured by Leidy ; the diameter of the triturating surface is only .66 of that of the same, (Leidy, l. c. xvi, fig. .6).

In the moderate development of the inner bulge, these teeth are like some of those of *M. wheatleyi*.

MEGALONYX TORTULUS, Cope, sp. nov.

Established on two corresponding canine-molars of opposite sides of a sloth, found in association with the preceding. These teeth are more dis-



tinctly curved than in the three species preceding, but are more as in *M. jeffersonii* and *M. loxodon*. Its shaft possesses a peculiarity of the latter, which is not seen in *M. wheatleyi*, *M. dissimilis* and *M. sphenodon*, i. e., it

is twisted, so that the vertical plate of the triturating surface is quite oblique to that of the basal portions of the shaft.

The triturating surface is, in its long diameter, transverse to the margins of the tooth adjacent; the short diameter is very oblique. The bulge is well marked, and in the specimens a little anterior to the middle. The inner layer of dentine is thickest anteriorly, where it is but a little narrower than the thick external layer, but it is nowhere very thin. The outer face is concave, a feature not seen in the three species above mentioned, and not exhibited by any of the sections of the teeth of *M. jeffersonii* given by Leidy, l. c.

	M.
Length of fragment of tooth	0.043
Long diameter grinding surface	.0232
Short " " "	.0145

These dimensions show that the *Megalonyx tortulus* is not larger than *M. sphenodon*, perhaps not so large, as the diameters of the apices of their teeth are identical, while that of the base is equal to the apex in the former, greater in the latter. The concavity of the outer face, and disposition of the dentine, are entirely different from that seen in *M.* and *sphenodon* other species, and more as in *M. jeffersonii* and *M. loxodon*.

For the better discrimination of these species, the following synoptic table of dental characters is added.

A Canine-molars, much curved, of equal diameter.	
Large, bulge median; grinding surface oblique.	*M. jeffersonii.*
Large, bulge anterior; grinding surface a groove.	*M. loxodon.*
Small, concave externally.	*M. tortulus.*
B Canine-molars little curved, of uniform diameter.	
Molars triangular, canine-molars less compressed, large.	*M. wheatleyi.*
Last molar oval, canine-molars more compressed, large.	*M. dissimilis.*
C Canine-molars little curved, diameter contracting to the apex.	
Bulge median, dentine thin within, small.	*M. sphenodon.*

Mylodon, Owen.

Mylodon ? harlani, Owen.

The remains representing this genus are not sufficiently characteristic to enable me to determine the species with certainty. They consist of two imperfect ungueal phalanges, and the distal extremity of the tibia. The former indicate a very large animal; they are stout, convex above, with lateral ridge and three basal plates. The flexor insertion is broad and flat, the foramina well developed. In the second phalange the middle inferior plane is represented by an obtuse angle. The tibia presents the excavation for the astragalus, as in *M. robustus* Ow,* but is narrower or with less anteroposterior diameter than in that species.

*See Owen on Mylodon. Pl. xx fig. 4.

Measurements.

	M.
Long diameter end of tibia	0.135
Short " " " (transversely)	.08
Vertical diameter ungueal phalange at nutritious foramina	.053
Transverse " " " " "	.037

These claws are similar to those of the *M. harlani* which have been discovered.

SCIURUS, Linn.

SCIURUS CALYCINUS, Cope.

Species nova.

Established on two imperfect rami of the under jaw, with the incisor and first, second and third inferior molars *in situ*. The size approximates it to the *S. hudsonius*, and exceeds that of the *S. panolius*. The forms of the ramus so far as visible, is not unlike that seen in the same squirrel. The characters which distinguish it from *S. hudsonius*, are chiefly to be seen in the molar teeth, especially the anterior. The crowns of all are deeply cupped, and the tritruating surfaces form anterior and posterior narrow bounding bands, which widen outwardly. The margin of the tooth is elevated and entire, except externally, where the two usual low cusps are separated by a deep notch. In the *S. hudsonius* the interior and exterior margins are both emarginate, each notch supporting a median cusp, thus forming three on each side. The anterior molar exhibits this character still more strongly. Its crown is a cup as wide as long, with high uninterrupted margin, except on the outer side, where it is deeply notched, It has but two roots. In *S. hudsonius* this tooth has three roots, is longer than wide, and has three marginal cusps on the inner and outer sides of the crown.

Length of three crowns m. 0048; length exserted portion of inferior incisor m. 007; transverse diameter do. at point of issue m. 0023.

From the extent of the worn surfaces of the molars, the animal described is adult. The second ramus is of the same size; the dental series is complete, and the teeth are worn so as to present a dentinal area surrounded by a thin margin of enamel. The outlines of the teeth are like those of the first specimen.

As compared with *S. panolius*, the species is larger, and differs in the form of the m. 1, as much as in the case of *S. hudsonius*.

JACULUS, Wagler.

JACULUS ? HUDSONIUS, Zimm.

One ramus mandibuli with incisor and second molar preserved. The latter nearly resembles the figure in F. Cuvier's Dents des Mammifers, and the ramus is about the size of that of the existing jumping mouse. Nevertheless, in lack of specimens of the cranium of the latter, I am unable to determine its specific relations, now first found in the Postpliocene.

HESPEROMYS, Waterhouse.

A ramus with first and second molars and incisor, agreeing in details of structure, with the group with which our recent *H. leucopus* is type, and of the size of that species, not certainly referable to the latter, without further comparison.

ARVICOLA, Lacep.

Remains of species of the genus are numerous in all the cave formations of the United States which I have examined. Those obtained by my friend, C. M. Wheatley, are referable to three sections of the genus, one of them the group Pitymys, as defined by Prof. Baird,† the others new; one intermediate between Arvicola and Pitymys, and third an exaggeration of the peculiarities of the last. They are defined as follows, the character of the sub-genus Arvicola being added for comparison.

Arvicola, Lac. Anterior lower molar triangles $1\ \frac{3}{2}\ \frac{3}{3}$, 1 three lobed; middle lower, $1\ \frac{3}{2}$; middle upper, $1\ \frac{3}{2}$.

A. riparia, Ord.*

Isodelta, Cope. Anter. inf. molar, $1\ \frac{3}{2}$; 1 three lobed; 2d inf. mol. $1\ \frac{3}{2}$.

A. speothen, Cope.

Pitymys, McMurtrie. Ant. inf. mol. $1\ \frac{3}{1}\ 1$, lobed; 2d inf. mol. $1\ \frac{1}{1}\ 1$.

A. pinetorum, Lec. *A. sigmodus*, Cope. *A. didelta*, Cope. *A. tetradelta*, Cope.

Anaptogonia, Cope. Ant. inf. mol. $1\ \frac{4}{3}$, 1 several lobed, the triangles all connected medially, the posterior nearly enclosed.

A. hiatidens, Cope.

The third group is represented by the greatest number of individuals and species.

ARVICOLA SPEOTHEN, Cope.

Sp. nov.

This species is represented by the entire dentition of the left ramus mandibuli, with a few fragments of the adjacent bone. As already pointed out, its characters entitle it to rank as a distinct section of the genus. Thus the triangles of the inner side of the anterior inferior molar are one less than in any species of the section *Arvicola*. The anterior loop presents two well marked angular basal areas, while its terminal portion is regularly rounded. The accompanying outline will give a good

†I have depended on Prof. Baird's well known work in studying this genus.

*ARVICOLA RIPARIA, Ord.
Baird, U. S. Pac. R. R. Surv, viii, 522.
This species has not yet been found in the Port Kennedy cave, and I introduce it for the purpose of recording its occurrence in the cave breccia, Wythe Co., Virginia, whose contents I examined and described in Proc. Am. Phil. Soc., 1869, 171. It is represented by a left ramus mandibuli, entire except in the angle and condyle, and with complete dentition. The size and proportions are identical with those of the existing species, as are also the triangles and form of terminal trefoil lobe of the anterior inferior molars. There is no difference to be observed between the third inferior molar when compared with that of *A. riparia* from Pennsylvania, but the anterior alternate triangles of the second, are not isolated, the reentrant inflection of the external enamel plate not reaching the internal, as in the recent animal.

idea of its form. That this is not one of the species of *Pitymys*, in which the basal lobe of the anterior trefoil has been cut off by unusual inflexion of the enamel angle, is demonstrated by the structure of the second molar, which is precisely that of typical *Arvicola*, all the triangles from the posterior being isolated and alternating, producing the formula, $1\frac{2}{2}0$. The third molar has the usual formula, 1-1-1, the posterior two lobes being crescentic, the anterior trapezoid.

Measurements.

	M.
Length grinding surface inferior molars, (No. 1)	0.0068
" " " 1st " " "	.003
" fang and crown " " " "	.005

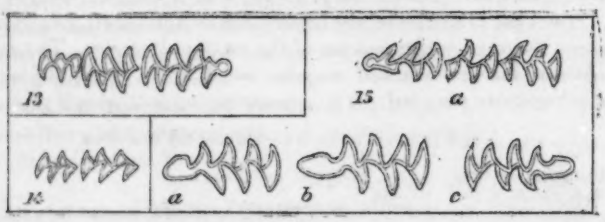
The structure of the molar triangles, i. e., their acuteness and thinness of enamel, induces me to describe here, without any certainty of reference, the superior molar teeth of one individual found near the same time. The formulae of the superior molars are (1) $1\frac{1}{1}$, (2) $1\frac{1}{2}$, (3) ? this, so far as known, identical with that of *A. didelta*. In another specimen represented by incisor and sup. m. 1., the former has an oblique antero-external face, with narrow truncate outer face; enamel not striate, emarginate at the cutting edge. In *A. didelta*, (fossil, below), the antero-external face is more oblique, and without defined external plane; the end is not emarginate (in one specimen). This tooth appears to be relatively smaller and weaker in the ?*A. speothen*.

	M.
Length fang and crown, 1st superior molar (No. 3)	.004
Width enamelled face incisor " "	.001

ARVICOLA TETRADELTA, Cope.

Sp. nov.

Represented by a portion of the cranium, which embraces the 2d and 3d superior molars, and parts of the m. 1, and incisor. The formula of the



two molars perfectly preserved is $1\frac{1}{2}$, $1\frac{2}{2}$. The terminal triangles are as well developed inside as outside; the others are rather small and obtusely angulated. Those of the m. 3, are entirely separated, and the last is not followed by a loop, but is completely enclosed behind by the vertical enamel plate, which bounds the corresponding triangle in the m. 2. This is a character which distinguishes this species from any other of the

genus Arvicola which has been described from North America, of which the corresponding tooth is known. The last triangle is slightly angulate in posterior outline.

	M.
Length grinding face of m. sup. 2 and 3.....	0.0037

It is only necessary to compare this species with the *A. speothen* and *A. involuta*, in which, unfortunately, the corresponding tooth is unknown. Its small and obtuse triangles distinguish it from the former. As reduction of the terminal loop of the m. inf. 1 is characteristic of the latter, the present tooth might be suspected to belong to it, but there is a real increase in the number of triangles over that of the most nearly allied species. *A. didelta*, and of the section *Pitymys*, to which it belongs, pointing most to the sections *Isodelta* or *Arvicola*. Size, .25 less than A. speothen.

ARVICOLA DIDELTA, Cope.

Species nova.

Represented by the mandibular rami of five, and superior dentition of probably three individuals. One imperfect cranium contains the dentition of both jaws, thus fixing the relations of fragmentary specimens, especially in the more important relation of the anterior, inferior and posterior superior molars. The characters of these show that it is allied to the *A. pinetorum*. The accompanying cuts illustrate the form of the first inferior molar tooth. The ridges are four internal and three external. The second molar exhibits the formula $1\frac{1}{1}1$, the anterior area with an approach to division into two triangles, alternating. This peculiarity is not seen in Prof. Baird's figure of *A. pinetorum*, l. c. liv. 1719, nor does the latter represent the loops of the last molar, as exhibited by our specimens. In the figure they are oval, in our specimens angulate crescentic. As the figure does not agree with the description, I do not rely on it for these details.

A more important difference is seen in the structure of the superior third molar, which Baird describes and figures as having but three isolated areas, the lateral angles being sub-opposite and confluent medially. In *A. didelta*, there is an internal and an external triangle, each entirely isolated, besides the anterior and the posterior loops. The last differs a little in its developments; in one it is broad heart-shaped, the apex posterior; in another elongate, the sides a little concave; in a third, more elongate and concave. The formula of triangles of both series then is: Sup. 1, $1\frac{2}{2}$. 2, $1\frac{1}{2}$. 3, $1\frac{1}{1}1$. Infer. 1, $1\frac{2}{1}1$. 2, $1\frac{1}{1}1$. 3, ?

Prof. Baird does not describe the triangles of the posterior superior molars in the *Arvicola austera* as isolated, though it might be inferred from his language. His figure, however, resembles that of the *A. pinetorum*. (See Baird, U. S. Pac. R. R. Surveys, viii, 539.)

ARVICOLA INVOLUTA, Cope.

Species nova.

Established on a nearly complete ramus mandibuli, with dentition perfectly preserved, It is nearly allied to the *A. pinetorum*, differing prin

cipally in the form of the anterior lower molar; (see accompanying cut). The anterior lobe of this tooth is much shortened and crescentic, the inner horn of the crescent being the apex of a ridge of the tooth. Thus there are five internal and three external ridges to the tooth. Triangles of inferior series (1) $1\frac{2}{1}1$ three lobed; (2) $1\frac{1}{1}1$; (3) 1, 1, 1. The anterior loop of the second molar is contracted, outlining two triangles. the lobes of the third are angular sub-crescentic, the anterior trapezoid. This molar differs distinctly in structure from that of the next species, q. v. The *A. involuta* is nearer the *A. pinetorum*, and is of the same size.

ARVICOLA SIGMODUS, Cope.

Species nova.

This species belongs to the same group (as characterized by dentition), as the last two, and is of about the same size, viz: about that of our common *A. riparia*. It is represented by three imperfect mandibular rami, two with dentition complete, the other with the posterior molar only wanting. Its characters are near those of *A. austera*, Lec., as pointed out by Prof. Baird. It differs from the *A. didelta* and *A. involuta* of the present paper, in the five lobed anterior loops of the first inferior molar. The loop has, therefore, besides the two basal unenclosed triangles, a smaller projecting angle on each side, and the terminal slightly angulated lobe. In the most typical specimen, the median angles of this lobe are as prominent (fig. a) as the basal, or the triangles, though the loop of the lobe is not angulated at the end.

There are, thus, five internal and four external ridges of the tooth. The triangles are as usual $1\frac{2}{1}1$, 5 lobed, (2) $1\frac{1}{1}1$, (3), 1, 1, 1. The anterior loop of the second is contracted as in the two preceding species. The third is quite different from that described under the head of *A. involuta*, and that figured by Baird for *A. pinetorum*. Thus, its three loops are chiefly extended inwardly, their outer angles projecting very little beyond the point of junction; they form a w or sigma-shaped grinding surface, whence the name of the species. Prof. Baird's figure of *A. austera* represents the first inferior molar of this species exactly, but is very different in form of the last, which is like that of the *A. involuta*. Should however, the character as here described in this tooth of *A. sigmodus*, be found to occur in the *A. austera*, the former name will become a synonyme of the latter.

Measurements.

	M.
Length grinding surface infer. molars, (No. 1.)	0.0065
" " " 1st " " "	.003
" fang and crown " " "	.004
Width inferior incisor	.0015

The dental series of the more typical specimen, whose m. 1 is outlined in fig. a, is smaller and relatively a little narrower than the others.

The supposed superior maxillary dentition is represented by both series, that of the left side lacking the first molar, with the palatine surface and

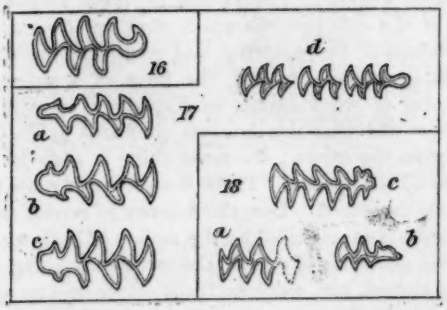
one upper incisor. The lobe formula is $1\frac{2}{3}$, $1\frac{1}{2}$, $1, \frac{1}{1}$ 1 three lobed. The lobe of the posterior molar is quite elongate, and divaricates into two angles anteriorly, the external of which is almost isolated, almost giving the formula for the tooth $1\frac{1}{2}$ 1. The teeth of both sides are exactly alike. The near approach to isolation of this external angle is due to the deep inflection of the posterior inner groove, and very near approach to a corresponding incurvature of the lobe. This specimen is referred to the *A. sigmodus* by the analogy to the relation between superior and inferior molars seen in *A. didelta*. In the latter the terminal loop of the inferior m. 1 is more simple and the loop of superior m. 3, agrees with it in its simplicity, having nearly the same form. The increased complexity of the anterior loop of the inferior m. 1 in *A. sigmodus* is shared by the m. 3 sup. here described, though not in exactly the same manner. I refer it, therefore, to this species with a reservation.

	M.
Length of dental series	0.007
Width between middle of m. m. 2	.005
" incisor tooth in front	.0015
Length from m. 2 to incisive foramen	.0049

ARVICOLA HIATIDENS, Cope.

Species nova.

Represented by several molar teeth. These are several times as large



as the teeth occupying the same position in any of the species already mentioned in this essay, and suggest the genus Fiber. The distinctive features of the latter are the compressed oar-like tail, with rooted molars, and it is evident that the relationship of this species is not to it. Perhaps it is neither an *Avicola* nor a *Fiber*, since it differs in the structure of the teeth from the known species of both. None of the triangles are isolated, but are connected by a narrow strip of dentine, which is narrow posteriorly but widens anteriorly until it opens out into the terminal loop. Thus the sectional name *Anaptogonia* may be found ultimately applicable to a separate genus. The separation of the enamel folds merely carries to the highest degree that which is seen in the anterior part of the tooth of *A. sigmodus*.

In the inferior m. 1, the triangles which do not open on one side to the anterior loop are $1\frac{1}{3}$, then one on each side, and the short wide terminal loop which is bilobed or emarginate in the middle of the end. The ridges, which are very prominent and acute, are, therefore, $\frac{6}{3}$; at the extremity there are two short ones, between which a third and more prominent one rises a little below the grinding surface. A little more attrition would give the distal loop a trilobate outline, and a little more, an acuminate one, from the loss of the lateral angles; finally the median ridge disappears also. In its present state one of the terminal lobes is almost external, making the ridges $\frac{6}{2}$.

Measurements.	M.
Length grinding surface	0.005
Width "	.0024
Length fang and crown	.0078

The accompanying cut of twice natural size explains the above remarks.

Two opposite molars held in natural relation by the matrix, resemble the above in structure and size so closely as to leave little doubt that they belong to the same species. Whether they should be referred to the superior or inferior series is uncertain, though analogy with the *Hypudæus gapperi* would suggest the latter. They represent the right and left second molars, and the triangular areas if isolated, would be $1\frac{3}{4}$, not one of them, however, is isolated, the dentine being continuous round the entering angles of enamel. The failure of these angles to reach the enamel margin of the side towards which they are directed, and an approach to parallelism of the entering and projecting enamel plates produces a triturating surface, having the form of a succession of Ws. This is the reverse of what occurs in *Hypudæus gapperi* according to Prof. Baird, where the triangles become confluent at their bases, thus extending all across the crown; the same thing is seen in the posterior inferior molar in all the species. There is no trace of roots to these teeth or that previously described. Length of crown of second molar, m. 0056.

A third specimen is represented by the molars of both maxillary bones, much broken, the posterior of one of the series only being entire. This tooth is slightly curved, and exhibits three ridges on one side, and four on the other; triangles $1\frac{2}{1}$ and a short loop with two basal angles, the inner more prominent than the other. None of these triangles are isolated, but are rather angular expansions of the continuous dentine. The two inner angles are much more prominent than the outer, but in old age they would probably be equal, judging from their appearance at the base of the tooth. Viewed from below, they appear to be closed, showing that the character of the group *Anaplogonia* in this respect is derived from a "retardation" of growth in a point which is early attained in true *Arvicola*.

	M.
Length of tooth	0.005
" crown	0.003
Width palate	0.004

ERETHIZON, Cuv.

The remains of a porcupine of the existing North American genus occur in the deposit. It is evidently different from the recent *E. dorsatum* and presents the following characters.

ERITHIZON CLOACINUM, Cope.

Species nova.

Represented by a last superior molar of the left side, and a portion of one of the inferior incisors. The former indicates the distinctness of the species by two peculiarities. One of these is the greater vertical depth of the external inflection of enamel. It is nearly as deep as the internal, while in *E. dorsatum* it is very much shallower, the internal extending down to the alveolar border. This appearance in the present species is not due to deficient attrition, for the molar in question is well worn, so as to leave the margins of the anterior island well posterior to the anterior enamel margins of the tooth. This anterior island is a transverse oval, slightly concave behind.

The general form of this tooth is T shaped, with an expanded triangular base. The second specific character is seen here; for while the recent species posesses an enamel island or annulus which occupies this space entirely, the *E. cloacinum* exhibits two, the additional one being on the inner side and smaller than the usual one. It is subovəl, and occupies the inner posterior angle of the triturating surface, which is expanded, and less than a right angle. I find no trace of this in five crania which I had the opportunity of examining.* The sizes of both this tooth and the incisor are about equal to the largest seen in the *E. dorsatum*. The enamel of the latter is not smooth, and has a minute interrupted striation.

Antero-posterior diameter of crown of molar m. 0076; transverse do. m. 0077; width anterior face of incisor m. 0055.

LEPUS, Linn.

LEPUS SYLVATICUS, Bachm.

Portions of crania of six individuals not distinguishable from this recent species. The palatal surface of one is exposed, and is longer in relation to its width than in a recent example. Thus in the former the length enters the width between the two anterior alveoli 1.2 times; in the latter 1.6 times. In Prof. Baird's figure it enters 1.4 times. Some of the specimens are smaller, some larger than the average of our recent ones. One of them had an oval mass of carbonaceous matter in its mouth, probably the remains of its unswallowed vegetable food.

PRAOTHERIUM, Cope.

Molars similar to those of *Lepus*, rootless, with oval crowns transverse to the axis of the series, all simple; masticatory surface not divided by median ridge, enamel boundary emarginate on the inner side. Number in maxillary bone? four.

* I owe a skeleton of the *E. dorsatum* from Muncy, Penna., to the kindness of my friend, Jas. S. Lippincott.

PRAOTHERIUM PALATINUM, Cope.

Species nova.

This rodent is represented by the palatal region of the cranium of one individual, with four superior molar teeth of each side in position. The latter diverge symmetrically, probably in consequence of pressure, But a

small part of the palatine surface is preserved. The normal number of teeth is uncertain, but the anterior tooth is known from its relation to the fragments of maxillary bone and perhaps zygomatic arch. It resembles the three molars which follow it. Behind the fourth no trace of tooth or bone could be found on exploring the matrix, though the latter was unbroken, hence it is possible, though not certain, that there were none.

The genus differs from those of the *Geomyinae* of Baird, in the simplicity of the first molar. The wide palate and narrower zygoma, as well as the forms of the teeth, are those of the rabbits, but it differs from the two genera, *Lepus* and *Lagomys*, in the identity of structure of the first molar with the others, and the absence of an enamel band dividing the triturating surface of each of them. In some of the teeth a trace of the dividing lamina is visible, but does not appear to have been elevated into a crest of the grinding surfaces.

In specific characters, this rodent differs from our rabbits in its small size, and in having the molars deeply longitudinally grooved on the inner face, instead of the outer. In worn teeth this groove is continued into the grinding surface of the crown, without interruption from the enclosing enamel. The form of this surface is then an oval, notched on the inner side, and rounded or slightly truncated on the outer. The palatine face is but partially preserved, and is considerably wider in proportion to the diameter of the teeth than in *Lepus sylvaticus*.

	M.
Length crown of four consecutive molars	0.0061
Width " one molar	.0021
" palate between bases of molars	.0100

SCALOPS, Cuv.

The only remain certainly referable to this genus is a humerus. As the

form of this element is very characteristic among the Talpidæ, the species may be determined from it with considerable precision. Its form is less stout than in *Talpa europæa* and *Scalops aquaticus*, but considerably more so than in *Condylura cristata*. In the uncertainty as to whether it can belong to *Scalops breweri*, I leave it without a name.

? VESPERTILIO, Linn.

Numerous slender bones referable to this or an allied genus, are found in the cave deposit.

MASTODON, Cuv.

MASTODON AMERICANUS, Cuv.

Numerous fragments of teeth, cranium, vertebræ, and extremities, of a large individual, with tusks measuring five to six inches in diameter. Some three-crested, and several primary or two-crested molars, indicate a second, smaller animal.

TAPIRUS, Briss.

TAPIRUS AMERICANUS, Auct.

Numerous teeth from all positions in both jaws indicate several individuals of different sizes. Some of them are of the size of the existing species of South America, and do not exhibit any differences of specific importance.

TAPIRUS HAYSII, Leidy.

Holmes' Postplioc. Foss. S. Ca., Pl. xvii. figs. 4, 5, 7, 8.

Four superior and six inferior molars do not differ in any respect from those of the preceding species. excepting in size. In this they exceed the latter, having about twice the superficial area. Leidy appears to have proposed this species on account of size only, and the specimens may indicate a valid species. Two superior molars, perhaps referable to the *T. americanus*, differ less in size, exceeding a little those of our recent specimens.

Dimensions of three superior molars of the largest (*T. haysii*), medium and smallest (*T. americanus*) size are given. The last two are worn, the first had not protruded through the gum.

	M.
Length, 1	0.029
Width, 1 (greatest)	.0332
Length, 2	.023
Width, 2 (greatest)	.029
Length, 3	.0218
Width, 3 (greatest)	.025

In addition to the teeth, there are numerous bones of the extremities, tarsus, &c., and vertebræ.

EQUUS, Linn.

Numerous phalanges of two species of slender proportions and smaller size than the recent domesticated horse. Neither the species nor genus are determinable as yet, from the remains.

Bos, Linn.

Extremity of a femur, several patellæ and fragments of metatarsals of a large species of ox or bison are preserved with the others. The species is not yet determined.

There are, perhaps, two other species of ungulate animals not as yet determined.

Ursus, L.

Ursus pristinus, Leidy.

Arctodus pristinus, Leidy. Proc. Acad. Nat. Sci., Philada., 1854, 90, Holmes' Postpliocene Fossils S. Carolina, 1860, 115, Pl. xxiii, f. 3–4.

This bear has been known hitherto by a molar of the lower jaw found by Prof. Holmes near Charleston, S. Ca., and the references above indicate descriptions and figures of this tooth alone. Mr. Wheatley's collection contains the first and second molars in a portion of the right ramus of the mandible, and the canine and first, second and third molars of the left ramus separated from it. There are also vertebræ of bears from the cervical and dorsal regions, which are appropriate as to size, and were found at near the same time as the teeth.

A character which at once distinguishes this bear from all those now living in the northern hemisphere (faunally speaking), and those known to have inhabited it during the postpliocene period, is seen in the first molar. Instead of the usual two series of tubercles, it has on its anterior half a single rather obtuse crest, above the outer side of the crown. The crest commences with the apex of an elevated conical tubercle, which marks a point three-fifths the length of the tooth from its posterior extremity. Two very small worn tubercles are seen behind it on each side, in the specimen, while the greater part of the surface of the crown is nearly plane, and covered by unbroken enamel. It is a little depressed, and compressed from the outer side at the posterior third. The enamel of the inner side of the crown is smooth, of the outer side obsoletely rugose. The second inferior molar is about as long as the first, but wider, and of different character. The triturating surface is parallelogrammic rounded at the ends, and narrowed at the anterior third, and contracted, as compared with the width of the base of the crown. The enamel, though worn, is nowhere worn through, and its surface is remarkable for the almost absence of tubercles. The grinding surface is concave transversely, and is bounded by elevated margins. The inner and outer display each three obtuse elevations, the latter the better defined, the anterior the most elevated and connected by a low cross ridge, which is depressed in the centre. The inner sides of the crown is swollen at the base, and more oblique than the outer; both are marked with obsolete ridges, which descend from the grinding face, those of the outer most distinct. The last inferior molar is two-thirds the length of the penultimate. The form is oval, broad anteriorly, narrow posteriorly. The crown is low and flat, without tubercles, the margin a little elevated, and interiorly and posteriorly mammillated; it has a single compressed root.

The inferior canine is represented by a crown. It is remarkably short, and stout at the base; the posterior outline very concave. The usual obtuse keel is seen on its anterior inner aspect, and worn surface postero-exteriorly. The apex of the crown is worn by use. The smaller premolars have not been recovered, but the last or sectorial has left its impression in front of the first molar in place in the matrix, and appears to have been of the proportions seen in the grizzly bear.

	M.
Length three inferior molars and fourth premolar together	0.096
do M. I crown	.029
Width do anteriorly	.013
Length M. II	.031
Width do anteriorly	.0202
Length M. III	.0233
Width anteriorly	.0188
" posteriorly	.0135
Length crown and root	.035

In size this species probably equalled the grizzly bear, as the teeth are as large as those of any of the numerous crania in the Museum of the Academy Natural Sciences, though Prof. Baird gives measurements of some in the Smithsonian collections, which are larger. Should the teeth be related to the skeleton as in our black bear *U. americanus*, a still larger size is indicated. The nearest relationship in the characters of dentition is to be seen in the *U. bonaerensis*, of Gervais* of Buenos Ayres. It has the peculiar form of the first molar seen in *U. pristinus*, but differs specifically in that of the second, which is interrupted in one of its outlines and rather more tubercular.

As compared with *Ursus amplidens*, Leidy, the following relations appear. The last molar has a smaller crown than in the type specimen of the latter. In *U. pristinus*, and the last is between .50 .75, the length of the second molar; in *U. amplidens*, exactly as in *U. horribilis*, five-sixths length of crown, or equal the extent of alveolæ. The third molar is less contracted behind in the type specimen of *U. amplidens*. The latter species appears to be in many ways nearly allied to the grizzly bear.

The discovery of this species by Mr. Wheatley, in Pennsylvania, is particularly interesting, as fixing an extended range for it, and proving that our cave bear is totally distinct from that of Europe, and rather of the type which was associated with the gigantic sloths in the southern regions of South America, at the same geologic epoch.

Felis, Linn.

Two proximal phalanges of a species of this or an allied genus, were found by Mr. Wheatley. They pertained to an animal of the size of the jaguar, (*Felis onca*). A fragment of a canine tooth indicates a cat as large as the tiger, but is too imperfect to allow of determination. Some vertebræ of a carnivorous animal, perhaps of a dog, were also found.

*Palaeontology of Castelnau's Anim. novo. on Rar. Am. Sud., Pl. fig.

The result up to the present time may be summed up as follows:

	Species.	Individuals.
Edentata.		
Megalonyx	5	15
Mylodon	1	?2
Rodentia.		
Arvicola	6	15
Hesperomys	1	1
Jaculus	1	1
Sciurus	1	2
Erithizon	1	1
Lepus	1	7
Praotherium	1	1
Undetermined	2	2
Insectivora.		
Scalops	1	1
Chiroptera	?1	6
Ungulata.		
Mastodon	1	2
Tapirus	2	4
Equus	2	3
Bos	1	3
Undetermined	2	3
Carnivora.		
Ursus	1	?2
Canis	?1	1
Felis	2	2
Mammalia total	34	72

Of birds there are fragments of two species, one a turkey, with the spur preserved, probably the *M. altus*, Marsh; (*M. superbus*,† Cope. Trans. A. Phil. Soc., 1870, pp. 239, ii), the other a snipe. The reptiles include one or two species of tortoises, and three or four serpents. There are a few bones apparently of Batrachians. The whole number of species of Vertebrata is about forty, represented by perhaps ninety individuals.

Dr. Geo. H. Horn, to whom Mr. Wheatley submitted the insects, reports, at an early stage of the investigation, thirteen species of *Coloptera* and two or three of other orders, including *Orthoptera*. We await with much interest the further results of this research, as the determination of Postpliocene Coleoptera has not been practicable heretofore. The names already published by Dr. Horn,* are, Carabidæ—*Cychrus wheatleyi Cychrus minor, Cymindis aurora, Chlaenius punctatissimus, Pterostichus laevigatus, Pt. longipennis, Dicaelus alutaceus;* Scarabaeidæ, *Aphodius scutellaris, Apho. micans, Phanaeus antiquus; Copris punctulatus;* Histeridæ; *Saprinus? ebeninus.*

† As it is now fifteen months since Prof. Marsh announced his species, and no description has yet appeared, it appears to me that *M. superbus*, the only name accompanying a description, will have to be adopted, if the two are really the same.

*Am. Jour. Sci. Arts, 1871, 385, in a notice by C. M. Wheatley.

General Observations.

Several authors have noticed the great difference in character between the postpliocene fauna of North America, and those which preceded it, in Tertiary time. It is well known, that while the Miocene Mammalia are more or less similar to those of Miocene Europe and Asia, and the Pliocene vertebrata have a corresponding resemblance to those of the same period of Europe and Asia, and the present one of Africa, the postpliocene resembles, in many particulars, that of South America or the Neotropical region.

In examining the list of postpliocene mammalia, known up to 1867,* I found, that of 30 species, eleven were represented by members of the same genus or family, in the Neotropical region. In an enumeration of the species from the caves in 1869,† which included 27 species of 23 genera, six genera were shown to be of neotropical type. In an unpublished list of vertebrata, which the writer exhumed in a bone breccia, from a cave in East Tennessee, there are twenty species included. Prominent among these, are *Megalonyx*, *Dicotyles*, *Tapirus*, *Cervus*, and *Sciurus*, the first three neotropical. The species from the Port Kennedy bone cave may be arranged as follows:

	Species.
Neotropical forms	11
Peculiar Nearctic (North America)	3
Genera common to north of both Hemispheres	11
Uncertain	9
Total	34

The theory of evolution requires that change of fauna in any very brief period of geologic time, should be accomplished by migration. Accordingly, authors have suspected that Asia and North America, and perhaps Europe, were connected by land during the miocene period. Thus Leidy, (Mammalia of Dakota and Nebraska, 1869, p. 360), suspects that North America was peopled from the west, from a continent now submerged beneath the Pacific Ocean. Prof. Huxley (Anniv. Address, Lond. Geolog. Society, 1870), makes a similar proposition, but adds that there is no evidence as to whether the connection was with Europe or Asia. In describing fossil *Cobitidæ*, a family of fresh water fishes, from Idaho, in 1871, (Proceed. Am. Philo. Soc., p. 55,) I have adduced evidence that the connection was with Asia. These *Cobitidæ*, as is well known, have no existing representatives in America, and are one of the Asiatic types, characteristic of our Pliocene period. As fresh water fishes, their migration is restricted to fresh water communication. Now, as the Rocky Mountain ranges were in large part elevated prior to Pliocene time, and the water courses had their present directions, it is obvious that the migration of fresh water fishes occupying waters on the west side of those ranges, must have been to or from the west, and not the east. That these

*Proc. Acad. Nat. Sci. Phila. 1867, 156. † Proceed. Am. Phil. Soc. 1869, 178.

fishes, then, passed through fresh water connections, existing on a continent now submerged beneath the Pacific Ocean, seems probable.

The destruction of the Pliocene fauna is generally admitted to have been brought about by the rigors of the glacial climate, and the extension southward of the ice sheet and snow falls. Near the same time, connection with Asia must have been severed by the descent of the North Pacific Continent. Some Pliocene types, not now existent in North America, may have been driven into the Neotropical region, and may be still represented in their descendants, the Lamas, the only existing *Camelidæ* of the new world, with the horses and perhaps others of the higher mammalia of that region. The existence of the extinct *Mastodon*, *Machaerodus*, etc., in the postpliocene of the same region, mentioned by Huxley, as a puzzling fact, (Address l. c.) may be accounted for in the same way.

Of course, on the northward retreat of the ice sheet, the mammalia fauna would have to be derived from the south, for communication direct with Asia no longer existed. If Behrings straits were not yet opened, the masses of glacial ice covering those regions would effectually prevent immigration by that supposed connection. The resulting Postpliocene fauna would naturally partake of the mixed character which our brief investigations into it have revealed. The neotropical forms would occupy regions left vacant, or peopled by a sparse remnant of boreal genera and species. This view I proposed some time ago,* and Dr. Leidy has added his valuable opinion to the same effect.†

Has any great disturbance of level intervened between the occupation of the post-pliocene fauna and the present period? Prof. Dana (Manual of Geology, 1862,) summarizes the results attained up to his writing (p. 553), by showing that the period succeeding the glacial drift was one of submergence, especially in arctic latitudes. He states the depression near Montreal to have been 450 or more feet, and 1000 feet in Arctic regions. Of the Middle States he says nothing, and of the south, that the evidence is not satisfactory. This descent of level he regards as that which caused the melting of the glacial ice, stratification of the drift, deposition of gravels, and elevation of temperature. All these changes would naturally precede the introduction of a postglacial fauna from a warmer region, so that for this and other reasons, the Champlain epoch may be regarded as that opening the post-pliocene, and its fauna to be represented by the Walrus, which extended its range to Virginia, the Reindeer to New Jersey, and the *Beluga* of the Champlain clays.

The origin of the caves which so abound in the limestones of the Allegheny and Mississippi valley regions, is a subject of much interest. Their galleries measure many thousands of miles, and their number is legion. The writer has examined twenty-five, in more or less detail, in Virginia and Tennessee, and can add his testimony to the belief that they have been formed by currents of running water. They generally extend in a direc-

*Proceed. Acad. Nat. Sci. 1867. 156. †Mammalia Dakota and Nebraska, 359, 1869.

tion parallel to the strike of the strata, and have their greatest diameter in the direction of the dip. Their depth is determined in some measure by the softness of the stratum, whose removal has given them existence, but in thinly stratified or soft material, the roofs or large masses of rock fall in, which interrupt the passage below. Caves, however, exist when the strata are horizontal. Their course is changed by joints or faults, into which the excavating waters have found their way.

That these caves were formed prior to the postpliocene fauna is evident from the fact that they contain its remains. That they were not in existence prior to the drift is probable, from the fact that they contain no remains of life of any earlier period so far as known, though in only two cases, in Virginia and Pennsylvania, have they been examined to the bottom. No agency is at hand to account for their excavation, comparable in potency and efficiency to the floods supposed to have marked the close of the glacial period, and which Prof. Dana ascribes to the Champlain epoch. An extraordinary number of rapidly flowing waters must have operated over a great part of the Southern States, some of them at an elevation of 1500 feet and over, (perhaps 2000) above the present level of the sea. A cave in the Gap Mountain, on the Kanawha river, which I explored for three miles, has at least that elevation.

That a territory experiencing such conditions was suitable for the occupation of such a fauna, as the deposits contained in these caves reveal, is not probable. The material in which the bones occur in the south is an impure limestone, being mixed with and colored by the red soil which covers the surface of the ground. It is rather soft, but hardens on exposure to the air.

The question then remains so far unanswered as to whether a submergence occurred subsequent to the development of the postpliocene mammalian fauna. That some important change took place is rendered probable by the fact, that nearly all the neotropical types of the animals have been banished from our territory, and the greater part of the species of all types have become extinct. Two facts have come under my observation which indicate a subsequent submergence. A series of caves or portions of a single cave once existing on the S. E. side of a range of low hills among the Allegheny mountains in Wythe Co., Virginia, was found to have been removed by denudation, fragments of the bottom deposit only remaining in fissures and concavities, separated by various intervals from each other. These fragments yielded the remains of twenty species of postpliocene mammalia.* This denudation can be ascribed to local causes, following a subsidence of uncertain extent. In a cave examined in Tennessee the ossiferous deposit was in part attached to the *roof* of the chamber. Identical fossils were taken from the floor. This might, however, be accounted for on local grounds. The islands of the eastern part of the West Indies appear to have been separated by submergence of larger areas, at the close of the period during which they were inhabited by postpliocene mammalia and shells. The caves of

* See Proceed. Amer. Phil. Soc. 1869. 171

Anguilla include remains of twelve vertebrates,* of which seven are mammalia of extinct species, and several of them are of large size. These are associated with the recent species of molluscs *Turbo pica* and a *Tudora* near *pupæformis*.† As these large animals no doubt required a more extended territory for their support than that represented by the small island Anguilla, there is every probability that the separation of these islands took place at a late period of time and probably subsequent to the spread of the postpliocene fauna over North America.

EXPLANATION OF THE CUTS.

Figs. 1–12. Sections of teeth of *Megalonyx* of the natural size.

Fig. 1–2. Sections of canine-molars of *M. loxodon*, Cope; 2a, profile of 2 from within.

Figs. 3–6. Sections of canine-molars of *Megalonyx wheatleyi*, Cope; 5a side view of 5 from the inner side.

Figs. 7–8. Sections of canine-molars of ? *Megalonyx dissimilis*, Leidy, or of *M. wheatleyi*, Cope.

Fig. 9. Sections of crowns of the superior molars of the right side of *Megalonyx wheatleyi;* from separated teeth, the anterior probably of this species.

Fig. 10. Sections of crowns of the inferior molars of the right side of *M. wheatleyi*, from specimens in place in jaw.

Fig. 11. Crown of tooth of *Megalonyx sphenodon*, Cope; 11a, same from the inside.

Fig. 12. View of canine-molar of *Megalonyx tortulus* seen from the crown; 12a, inner view of same tooth.

Fig. 13. Grinding surfaces of left inferior molars of *Arvicola speothen*, Cope, enlarged.

Fig 14. Grinding surfaces of second and third superior molars of *Arvicola tetradelta;* Cope.

Fig. 15. Same of *Arvicola didelta*, Cope, enlarged; a, b, c, of the first inferior molar; d, of the superior molars.

Fig. 16. First inferior molar grinding surface of *Arvicola involuta*, Cope, enlarged.

Fig. 17. Same of *Arvicola sigmodus*, Cope, enlarged; a, b, c, of first inferior molar; d, of superior molars.

Fig. 18. Same of *Arvicola hiatidens*, Cope, enlarged; a superior molar 1 or 2, incomplete; b, 3d superior molar; c, 1st inferior. The entering folds should not be in contact in figs. *a* and *b*, in cuts.

Fig. 19. Grinding surface of last superior molar of *Erithizon cloacinum*, Cope, natural size.

Fig. 20. Superior molar teeth (incomplete) of *Praotherium palatinum*, Cope, natural size.

* Loc. cit. 1869. 183; 1870, 608. A fourth species of gigantic Chinchillid has been found by Dr. Rijgersma, which may be called *Loxomylus quadrans*, Cope. It is represented by portions of jaws and teeth of three individuals. It is one of the largest species, equalling the *L. latidens*, and has several marked characters. Thus the roots of the molars are very short, and the triturating surface oblique to the shaft. The roots of the second and fourth are longer than those of the first and third. The last molar has four dental columns instead of three as in the other *Loxomyli*, and is triangular or quadrant-shaped in section: the third is quadrangular in section, and has three columns. The second is the smallest, being only .6 the length of the subtriangular, first. Length of dental series m. 063 or 2.5 inches. Palate narrow and deeply concave. There is but little or no lateral constriction in the outlines of the teeth: the shanks are entirely straight. In its additional dentinal column, this species approaches the genus *Amblyrhiza*.

The large Chinchillas of Anguilla are as follows, *Loxomylus longidens*, *L. latidens*, *L. quadrans* and *Amblyrhiza inundata*.

† See Bland, Proceed. Amer. Phil. Soc., 1871, 58.

ON MEGAPTERA BELLICOSA.

By E. D. Cope, A M.

(*Read October* 21, 1870, *before the American Philosophical Society.*)

For many years American Whalers have been in the habit of taking hump-back whales off the coast of San Domingo, and in other parts of the Caribbean Sea. Desiring to determine the species which is the object of their pursuit, and which, no doubt, haunts the Floridan and

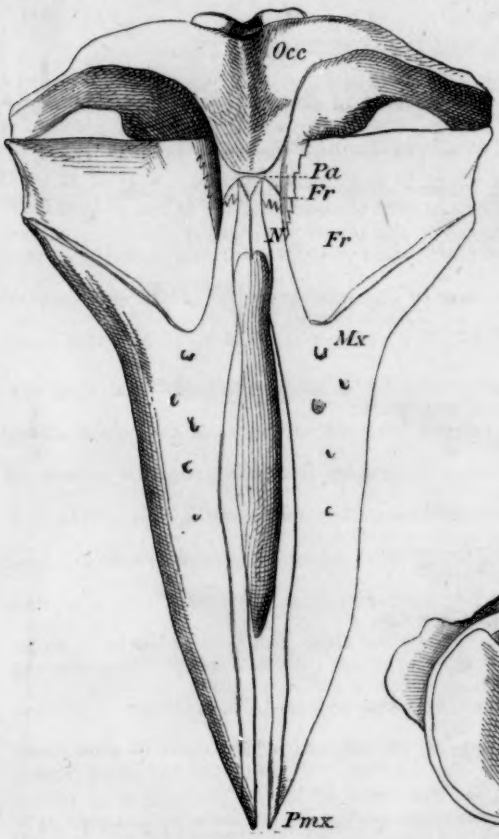


Fig. 21.

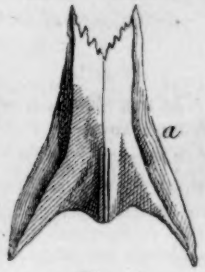


Fig. 22.

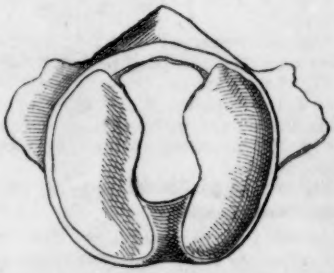


Fig. 26.

other southern coasts of the United States, I wrote to my friend, Dr. A. Goës, colonial physician at St. Bartholomew's, W. I., in reference to the possibility of procuring a skeleton of it. His efforts, undertaken in pursuance of this object, resulted in the preservation of the skeleton of an individual of thirty-two feet in length, which he forwarded to Philadelphia, and which has furnished the following characteristics.

The skeleton lacks a few pieces, viz.: the sternum, pelvic bones, and perhaps four caudal vertebræ. Of the latter, one is a large anterior vertebra, two are median, and one between the latter and the distal. The whole number thus restored will be, Cerv. 7, D. 14, L. 10, Caud. 20; total 51. The lengths of the cranium and these elements are:

	Ft.	In.
Cranium	9	
Caudal vertebræ	8	10
Remainder of vertebræ	13	6
Total	31	4

The *cranium* is not very different in some respects from that of the *M. longimana* of the North. The supraoccipital bone has a deep but open median groove from the foramen magnum to near the horizontal superior surface, where it is wanting. On each side of it there is a considerable protuberance near the middle of the height of that bone.

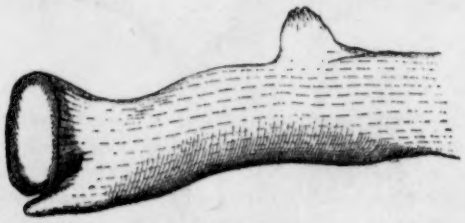


Fig. 23.

Fig. 24.

The orbital plates of the frontal are plane, with straight anterior and posterior margins. The posterior extremities of the premaxillaries are laminar; their middle portions are separated by a considerable vacuity. The maxillaries are not slender, and are plane; they present several large foramina near their middle. The nasal bones present marked characters. Their median face of common contact extends throughout much of their length, and the posterior divergent portion is very short (see fig. 22), and serrate for suture. A beveled portion of the external face (fig. 22a) is concealed by the maxillaries; the remaining portion is narrow. The median projection of the bones is less than the lateral, and is carried on a keel above the level of the lateral portion of the bone, as

in *Sibbaldius tectirostris*, Cope. The whole form is very different from that of the *M. longimana*. The depth and length of the bone on the interior (median) face, are about equal. The otic bulla is subcylindric, a little flattened on the inner side; its surface is quite smooth.

The ramus of the mandible is slender, and when viewed from above, considerably curved. It has an elevated subtriangular and acuminate coronoid process, quite as in a Balænoptera. (Fig. 24 from above.) Proximally the ramus has a slight sigmoid curve viewed from the side (fig. 23), and in the general is more slender than that of *M. longimana*, in profile. The angular process is prominent; the shaft is plane on the inner side, on the external very convex; it is nowhere compressed, and the external pores are widely separated.

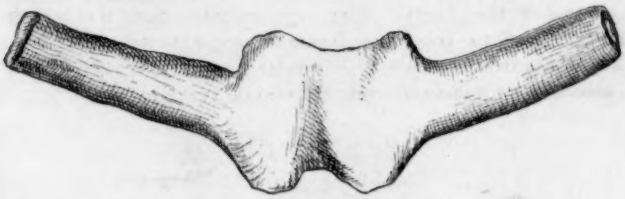


Fig. 25.

The atlas has no neural spine and no *tuberculum atlantis*. The diapophyses are compressed, irregularly truncate, their inferior margin considerably above the fundus of the *foramen dentati*. The axis presents a rudimental odontoid process. Its diapophysis and parapophysis are not very stout, and the former is the longer. The parapophyses diminish rapidly till the fifth vertebra presents only a rudiment on one side. The articular faces of these cervicals are a transverse ovate. The diapophyses are slender and straight. (See figs. 26 atlas, 27 axis, and 28, third cervical.)

Fig. 27

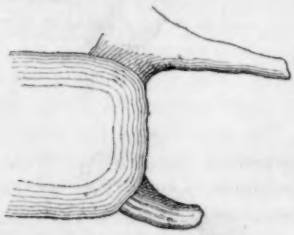


Fig. 28.

Two of the diaphophyses of the caudal vertebræ are hooked in form, owing to the failure to isolate anteriorly the foramen which pierces them. The scapula is without rudiment of coracoid and is longer than deep; its proportions are similar to those of *M. osphyia*.

The fore limbs are neither of them quite complete. The epiphysis of the humerus is still free, and indicates that the animal was young when captured. The bones of the forearm are much as figured by Rudolphi

in the *M. longimana;* the radius stout, expanded at the ends, the ulna shorter, more slender, curved and with an olecranon. The metacarpi, or the first series, are quite elongate, except that of the upper (inner) digit, which is stouter. If there were six digits in the second digit (third), the limb measured 8 feet 4 inches, but if, as in *M. longimana*, there were eight, it equalled the cranium in length (9 feet).

Measurements.	*ft.*	*in.*
Total length of skull, (axial)	9	
Length of maxillary to emargination for frontal plate	5	5
" transverse, (to axis of skull) of orbital frontal plate	2	5
" longitudinal " " "	2	2
Distal width over orbit " " "		11.5
Length nasal bone		9
Width " "		1.5
Width cranium behind orbits, (greatest)	5	4
" muzzle half way to frontal plates	2	3.5
" maxillary $\frac{3}{4}$ way " "		10.5
Length mandibular ramus on curve	9	10
First rib, length on curve		37
" " distal width		7
Humerus length	1	9
Radius "	2	6
Scapula height		25.5
" width		39.5
" glenoid cavity length		11.5
" " " width		9

The simple headed first rib indicates the generic relationships to be with Megaptera, as does the entirely simple scapula.

In reply to my enquiries, Dr. Goës gives the following account of the external appearance of this whale. The dorsal outline is strongly convex, and it is questionable whether a dorsal fin exists, as he had not seen it on two specimens from the decks of the vessels to which they were fastened. The color is sooty black above, the breast, belly, and under sides of pectoral fins milk white, marked with scattered black spots or dots.

The condition of the specimen allows of an exact comparison with the species of this genus already known from the Atlantic Ocean. The skeletons of the two Pacific species, are unfortunately unknown, so that comparison with them cannot be made.

From *M. lalandii* of the Cape seas, it may be at once distinguished by its lack of acromion process on the scapula. Cuvier, who figures the Cape species,* does not indicate the deep occipital groove, but rather a keel without lateral protuberances, a difference too marked to be dependent on age; his orbital plates of the frontal are considerably narrower, and his fourth cervical bears no parapophyses. He does not figure such a prominent coronoid process. The coloration of this species is much like that of the West Indian whales.

*Ossemens Fossiles, 227-1.

Many marked differences separate it from the Kreporkak, of the northern Atlantic and Arctic Oceans. The elevated coronoid process and peculiar nasal bones distinguish it at once. Thus in *B. longimana* these elements are shorter and wider, considerably separated behind, and with the median process which overhangs the nares, considerably longer than the lateral. The reverse is the case here (fig. 2). The head bears a greater proportion to the length of the body than in *B. longimana*. Thus Flower notes a specimen in mus. Louvain (Belgium), of 32 feet 2 in. in length, of which the head measures only 8 ft. 6 in. In the present of 31.6 in., the cranium is 9 ft. In a specimen at Brussels of 46 ft., the head is 12 ft., nearly one fourth. In a young specimen of 28 ft. 7 in., at Leyden, Flower says the cranium measures only 7 ft. 7 in. In a specimen from the Dee, England, the proportions are similiar. As the length of the flippers is similar to that of the head, the difference is to be seen in this also. Other characters which distinguish the species from *B. longimana*, are the less concavity of the orbital plates of the frontal anteriorly, and the reduction of the lumbosacrals to 10. If Rudolph's figures be correct, the first rib is broader in the present animal, but the figure may be inaccurate. As to color, the pectoral fin is entirely white in the Arctic *Megaptera;* black externally in this one.

The same differences are to be observed in comparing with the *M. osphyia*, in which the head and fin are even shorter than in *M. longimana*, (the proportion being 9.40*) and the coronoid process equally rudimentary. Special features of the latter are seen in the flat, deep diapophyses of atlas, which are much deeper than in the present whale ; and the articular area on the hinder angle of the first and other ribs, which is wanting here. The width of the orbital plates distally is, .5 their length in the type of M. osphyia, .83 the length in the present specimen.

The species described by Gray (Catal. B. Mus., 1866, 162,) as *Physalus brasiliensis*, founded on some baleen of the "Bahia finner," has been supposed by me (Proc. A. M. Scie. Phila., 1867, p. 32,) to be a Megaptera. Certain it is that a Megaptera is found at Bahia, as I have seen larger and smaller portions of two skeletons of one, but whether it be the "Bahia Finner" and *P. brasiliensis*, Gray, is quite doubtful. In the first place, fishermen and whalers never call a "hump-back" (Megaptera) a "finner;" if they have done so in the case of this species, it evidently has a noticeable dorsal fin, which is wanting in the present whale. In the next place, baleen of the "Bahia finner" has a commercial value, being exported to England, while that of Megaptera has none, being coarse and twisted. That of the specimen here described was thrown away by it captors.

I therefore believe that the present whale has not been noticed by naturalists, and is unknown to Zoology. I propose to call it MEGAPTERA BELLICOSA.

Dr. Goës says of its habits, that it appears about the island of St. Bartholomew in the beginning of March, or even in February, and remains

*See Proc, Ac. Nat. Sci., 1868-194.

until the end of May. In April and May it is said that they are seen in pairs, standing vertically in the water. When they return, they often come in a family of three, male, female and young, the calf of one or two years old. The bull is wild, and more difficult to take than the female, and he has, on two occasions, smashed the boat of his pursuers to pieces. In June they are said to go farther in the Mexican Gulf, and return eastward in the autumn, but they do not appear among the smaller Antilles at that time.* Dr. Goës supposes that they pass the straits of Florida, or follow the shores of the South Main. He says that the whalers think they pass the middle of winter on the African coast, but this will require confirmation.

Additional note on BALAENOPTERA vel SIBBALDIUS SULFUREUS, Cope.

This species was first brought to the notice of zoologists by Captain C. M. Scammon, in an extended paper on the Cetacea of the Pacific Coast of North America.* From the data furnished by him, the writer was enabled to determine it as distinct from any of the species hitherto known, under the above name, with the following characters :†

Dorsal fin small, conic, situated on the posterior fourth of the back. Form slender ; length seventy to ninety feet. Color, above, grey or brown ; below, sulphur yellow.

Capt. Scammon having sent to the museum of the Smithsonian Institution four laminæ of whalebone, I am enabled to add important points to the above diagnosis, as follows :

Baleen black everywhere. Bristles intermediate in size, between those of Sibbaldius tectirostris, Cope, (finer) and Megaptera osphyia (coarser), in six or eight rows, and seven or eight inches in length. Length of plate, without bristles, two ft. eight inches ; width of base eighteen inches. Laminæ with weak transverse rugosities.

The above characters show conclusively that this whale is different from the *B. antarctica*, Gray, which is also called sulphur-bottom by the whalers in the South Pacific. The whalebone of the latter is yellowish white.

EXPLANATION OF CUTS.

Fig. 21—Cranium of *Megaptera bellicosa* from above.
Fig. 22—Nasal bones from above.
Fig. 23—Posterior portion of ramus mandibuli, from outside.
Fig. 24—Same as 23 from above.
Fig. 25—Basihyal bone from above.
Fig. 26—Atlas from front.
Figs. 27 and 27—Portions of articular faccs and processes of atlas and third cervical vertebræ.

*Proceed. Acad. Nat. Sci., Phila. 1869, p. 51.

† Loc. cit., p. 20.

Stated Meeting, April 7th, 1871.

Mr. FRALEY, Vice-President, in the Chair.

Present, twelve members.

Donations to the Library were received from the Academies at Berlin and Leyden, the Royal Society at London, and the Editors of Nature, the Old and New, and Penn Monthly, the New Bedford Public Library, Medical Journal, Franklin Institute, College of Pharmacy, Academy of Natural Science at Philadelphia, the Engineer Bureau at Washington, Essex Institute, Wisconsin Historical Society, and from Prof. Mayer, of Bethlehem.

Prof. Cresson laid before the Society a map of Fairmount Park, reduced by photolithography to a very small size, yet exhibiting every line clearly.

Prof. Cope described additional new genera and species from the Port Kennedy Cavern, nearly one half of which were of South American types.

Mr. Chase read a communication on "The Resemblance of Atmospheric, Magnetic and Oceanic Currents."

Lieut. Dutton explained his views of the origin of Regional Subsidence and Elevation.

The curators were requested to provide for the proper preservation of the Photographs of Lines of Magnetic Force, presented to the Society by Prof. Mayer.

Pending nominations were read and the meeting was adjourned.

Stated Meeting, April 21st, 1871.

PROF. CRESSON, Vice-President, in the Chair.

Present, eleven members.

A Photograph for the Album was received from Prof. Alexander Braun, of Berlin.

Letters acknowledging the receipt of the Society's recent publications were received from the Institute at Halifax, (entire series of Proceedings No. 1-84), New York Lyceum (85); Royal Society of Edinburgh, 78, 79-81, and Trans. (XIII. 3); and the Royal Saxon Society (XIII. 3).

Letters of Envoy were received from the Society at Görlitz, and the Editors of Old and New.

Donations for the library were received from Dr. Braun, of Berlin, the Upper Lausatian Society, the Anthropological Society and Geological Institute at Vienna, the Italian Geological Committee, M. Seguin ainé of Paris, the Linnean, Chemical, Asiatic and Antiquarian Societies in London, the Editors of Nature, the Royal Society at Edinburgh, the Philosophical Society at Glasgow, the Institute of Sciences at Halifax, the Peabody Academy at Salem, Silliman's Journal, Prof. Hall of Albany, the Young Men's Association at Buffalo, Mr. H. C. Bolton of New York, the New Jersey State Geologist, the New Jersey Historical Society, the Franklin Institute, and the chief of the U. S. corps of Topographical Engineers.

The death of Wm. Haidinger of Vienna, on the 19th ultimo, was announced with appropriate remarks by Dr. Genth.

The death of Edward Lartèt, in the department of Gers, during the late German investment of Paris, was announced by the Secretary. Mr. Cope added his personal testimony to the value of the Palæontological labors of the deceased.

Prof. Cope offered for publication in the Proceedings, a Preliminary Report on the Vertebrata discovered in the Port Kennedy Cave.

Dr. Genth described some striking results of recent analysis of Pseudomorph Corundums, and promised a fuller account of them when his investigations were further advanced.

Prof. Cresson desired a memorandum to be made of the appearance of the tender shoots of the swamp cabbage, blue bell and other wild flowers, under remarkable circumstances of difficulty, in a part of Belmont Glen, in the Philadelphia Park, where an artificial asphalt road had been laid directly upon the sod. The road was two inches thick, perfectly solid, and in use by vehicles. Yet this rigid and heavy covering has been lifted and broken in many places by the young plants, which present themselves in a living, although damaged condition to the air and light.

The Secretary described a new discovery which he had just made in East Tennessee, of a sharp anticlinal axis, crossing the coal measures of the Cumberland mountains, at right angles to the dominant system of disturbances, and showed its important bearings on the question of the conversion of the northern anticlinals into the southern downthrows, as well as its relationship to the latter; and to the cross undulations worked out by Mr. Joseph Lesley, in his instrumental survey of the East Kentucky coal measures, twelve or thirteen years ago; and also to the N. W., S. E. system of faults described by Owen, Hall and other Geologists, in the valley of the Mississippi.

Mr. Briggs described certain movements observed under the microscope in matter mechanically suspended in a fluid and vulgarly supposed to indicate vital force, a view from which he dissented, referring to Baron Rumford's recorded observations of the same phenomenon. Mr. Briggs took occasion to exhibit for the inspection of the members, the Watt medal which he had received from the Society of Civil Engineers in London.

Pending Nominations Nos. 669 to 674 were read, and balloted for, after which the presiding Officer pronounced the

following named gentlemen duly elected members of the Society:

Gen. Herman Haupt, of Philadelphia.

Prof. E. B. Andrews, of Marietta, Ohio.

Rev. F. A. P. Barnard, D. D., LL. D., President of Columbia College, N. Y.

Rev. T. D. Woolsey, D. D., President of Yale College, New Haven, Connecticut.

Rev. James McCosh, D. D., President of Princeton College, New Jersey.

Prof. Charles W. Eliot, President of Harvard College, Cambridge, Massachusetts.

And the Society was adjourned.

Stated Meeting, May 5, 1871.

PROF. CRESSON, Vice-President, in the Chair.

Present, fourteen members.

A letter accepting membership was received from Charles W. Eliot, dated Cambridge, May 1, 1871.

A letter acknowledging receipt of Trans. A. P. S. XIV. I. was received from the Secretary of the Smithsonian Institution.

Donations for the Library were received from the R. Prussian Academy, R. Astronomical Society, Sir Charles Lyell, Editors of Nature, Old and New, Penn Monthly and Canadian Naturalist, the Peabody Academy at Salem, Boston Natural History Society, Massachussetts Historical Society, New York Lyceum, College of Pharmacy, Baltimore Public School Commissioners, Hon. Charles Sumner, Dr. Hayden, P. B. Dyke, and a Map of St. Domingo from Dr. Genth.

The Secretary read the description of a new and improved field transit instrument, manufactured by Messrs. Heller and Brightley of Philadelphia; and exhibited the parts of the instrument which show improvements.

The Secretary read from Mr. Jno. Fulton's report of the Mammoth Fossil Ore bed discovered in 1867, in Woodcock Valley, Blair Co., Pa., in evidence of what important discoveries may still be made in districts of the State supposed to be well known.

The Secretary offered for publication in the Proceedings, a Grammar and Vocabulary of the Mexican language, by Mr. Adolf Burck, which was referred to Dr. Brinton.

Mr. Chase exhibited two corresponding Curves; one of the annual auroral curve at New Haven; the other of the annual rain curve at Philadelphia; and described the probable cause of their agreement.

And the Meeting was adjourned.

Stated Meeting, June 16, 1871.

PROF. C. B. TREGO, in the Chair.

Present, five members.

A photograph of Mr. Joseph Saxon was presented by him self, for insertion in the Album.

A letter of envoy was received from the U. S. Naval Ob servatory.

Donations for the library were received from the Berlin Academy, London Astronomical Society, Editors of Nature, Geological Survey of Canada, Essex Institute, Boston Public Library, Massachusetts Historical Society, Editors of Old and

New, Cambridge Museum of Comparative Zoology, Mr. Edmund Quincy, Silliman's Journal, New York State Library, American Literary Bureau, Franklin Institute, Medical News, College of Pharmacy, Board of Water Works, Fairmount Park Commission, Penn Monthly, C. M. Wheatley of Phœnixville, Pennsylvania Board of Public Charities, Smithsonian Institute, U. S. N. Observatory, and Georgia Historical Society.

The Committee to whom was referred the Aztec grammar and vocabulary of Mr. Burck, reported against its publication, and the Committee was discharged from further consideration of the subject.

Mr. H. W. Field, a member of the Society, was appointed to prepare an obituary notice of the late Sir John F. W. Hershel.

Mr. Lesley communicated to the members present, certain geological facts respecting the percentage of volatile matter in the six-foot coal bed near Ursina, Somerset County, Pennsylvania, and the percentage of titanic acid in the iron ores near Greensboro, North Carolina, with a view to placing them on record.

Mr. Chase communicated a note upon the English wind-tables, and a note upon the nature of the Tidal Wave.

Mr. Cope announced that 800 species of fish had been received by him from Vienna, in good condition, being that part of Prof. Hyrtl's Osteological Collection which Prof. Cope had secured, against the competition of the British Museum, and other European Cabinets desirous of possessing it, and described the admirable character of the preparations.

Pending nominations, Nos. 677 and 678 were read.

An extract was read from a letter of M. Carlier to M. Durand, respecting the Michaux rentes.

On motion of Mr. Cope, an appropriation was made of an additional sum of $35, to cover the total expense for the illustrations of his paper on Megaptera Bellicosa, published in the proceedings, and his paper on the Fishes of the Lesser Antilles, published in the transactions.

And the meeting was adjourned.

Heller and Brightley's New Transit.

The Engineers and Surveyors' Transit as at first constructed commonly termed a "flat centre," or "Railroad Transit," although superior to the English Theodolite which it superseded, yet in practice has been found defective in the following mechanical details.

1st. The upper or vernier plate, resting and turning upon the under or graduated limb, was accompanied by so much friction, caused by the large extent of the rubbing surfaces, that in turning the vernier plate around the limb, the whole instrument would sometimes be moved upon the lower spindle.

2d. The oil that was necessarily used to lubricate the plates, would become so congealed in cold weather that the plates would not move at all, and old Railroad Engineers will readily recall the thawing out of their instruments over large fires, at every fall of the thermometer, before they could be used.

3d. The spindle upon which the entire instrument turns, being detached from the instrument, thus violating one of the standard rules, that by long experience in this country and Europe, has been found necessary in the construction of any instrument with any pretensions to accuracy, viz.: "*any instrument having a graduated plate and levels should be so constructed that both of the centres upon which the instrument turns should be always covered and not detachable from the main plates.*" To prove the utility of this rule, it is only necessary after adjusting the levels of one of this class of Transits so that they will reverse on the top centre, to clamp the two plates together, and turn the instrument on the lower spindle, and the levels will invariably be found out of adjustment, showing conclusively that through some cause, most frequently the settling of flying dust, etc., upon the surface and shoulder of the spindle, the spindle is not at right angles to the surfaces of the plates.

4th. The centre around which the graduated limb revolves can only be the thickness of the graduated limb; this centre by reason of its small surface wears after comparatively short use, and does not exactly fit the conical hole in the graduated limb, and two readings of the same object taken without any change in the position of the instrument have been found to differ by 5′, and from no other cause than this.

These various defects have caused this style of instrument to be entirely discarded in city work, and for this another construction is used in which the two main plates do not touch each other, thus obviating the two first evils, viz.: the friction of the two plates rubbing one over the other, and the stiffness of motion of the plates in cold weather. The sockets and spindles upon which the main plates revolve being long and fitting

one inside of the other, and neither of them being exposed or detached from the instrument, thus remedying the two last causes of error. These two are the only styles of Transit made, and are respectively termed the "short centre Transit" and the "long centre Transit." The "long centre," although the most perfect in its construction, has never been a favorite among Railroad Engineers for the following reasons:

1st. The increased size of the centres making it heavier, and this being a very serious objection where an instrument must be carried several miles every day as is frequent in Railroad surveys.

2d. The instrument not being detached from the tripod, except at the base, compelled the Engineer in moving the instrument from one station to another to either carry the entire instrument himself or trust it to his assistant, while in the short centre, the instrument lifting off the spindle, the Engineer could take the comparitively light instrument with all the important parts, and leave his assistant to carry the heavier portion of the tripod with its leveling screws, legs, etc.

3d. The removing and replacing of the instrument on the tripod being accomplished by means of a large screw thread, is a very tedious and unsafe method, and if not very carefully performed is liable to injure the instrument.

4th. The extra skill, time, and care required in making the long centre was so much greater than the flat centre, that the price of the instrument was materially increased.

Ever since the introduction of the Transit numerous endeavors have been made to reduce the weight of the instrument, but as they have all been conducted on the same principle, *i. e.*, reducing the thickness of the various plates, etc., their only effect was to make the instrument so slight as to be unsteady, their bearing surface so short as to soon wear loose, and the instrument always losing its adjustment. The manufacturers of this instrument have had their attention drawn to the increased strength and steadiness that the employment of the "transverse section," "ribbing or bracing," imparted to metals; and the amount of metal that could be removed from a solid plate of metal, and its strength and steadiness not impaired, but even added to, if only judicious ribbing was resorted to. In this improved Transit, which is a long centre, the weight as compared with an ordinary Transit of the same size is reduced one-half, and the instrument is not contracted in any part, but in some parts where increased size would be an advantage, such as the graduated plate, centre, etc., it has been done, but all the plates, etc., are ribbed in such a way as to be stronger than a solid plate, and all metal that did not impart either strength or steadiness has been removed.

The Railroad Engineer has in this instrument a long centre Transit that can be taken from off the tripod and replaced in a quicker and surer

way than the short centre Transit, but unlike the short centre, keeps all the centres covered and not removable from the instrument, and leaves the tripod head and legs with the four levelling screws, etc., to be carried by his assistant. The difference in weight will be appreciated by the Railroad Engineer when we inform him that a plain Transit with all its centres, etc., only weighs about as much as a Surveyor's Sight Compass, and is more steady and keeps in adjustment better than the ordinary long centre transit, weighing from 25 to 30 pounds.

The City Engineer has in this instrument all the advantages of the ordinary "long centre Transit" with only half the weight, and an increase of steadinsss.

There are several defects that are common to all Transits, among which are—

1st. The "tangent or slow motion screw" that moves the upper or vernier plate, by use becomes worn and does not fit precisely the thread in the interior of the nut through which it passes. When this occurs the tangent screw can be turned sometimes a complete revolution without moving the vernier plate. This "lost motion" or "back lash" of the tangent is one of the worst annoyances of Engineers, and has been the source of serious errors in the field. Several methods have been devised to overcome this which we will here describe. The nut through which the screw works has been made in two sections to allow of being drawn together when the screw wears. This plan would answer if the screw always wore equally in every portion of its length, in other words was a cylinder, but this it never does, and if the nut is tightened so that the lost motion is removed from the thinner portion of the screw, it will move so tightly as to be useless when it comes to the portions that are not worn so thin. There are several methods of drawing the nut together, but they have all the same objections as the above, that is, they are not effective in the entire length, and the nut must be pressed so very hard on the screw as to make the working of the tangent very tense, especially in cold weather. Another, and the last method has been to apply a long spiral spring between the nut and the head of the screw that acts as the finger piece, thus pressing the nut and the screw from each other, and consequently removing all "lost motion" from the screw. This plan though in theory very good, in practice has been found inoperative, for the following reason: the spiral spring had of necessity to be made long enough, and stiff enough, to act in every portion of the screw's length, the alternate opening and closing of the spring by use weakened it, and in a short time it failed to remove the "back play." To get rid of this defect of "lost motion" in the tangent screw, opposing or butting screws have been sometimes substituted, but in use they do not give satisfaction, as two hands must be employed in using them, and standing from the edge of the plate, they are liable to be injured by blows, and they are apt, unless very carefully used, to throw the instrument out of level.

In this instrument we have an improved tangent screw; that no matter how much the screw may wear by use, or time, will never get "lost motion," but will instantly obey the slightest touch of the hand: this is effected by means of a long cylinder nut, from the interior of which two-thirds of the screw have been removed; into half the recess thus left in the nut, is nicely fitted a cylindrical "follower," with the same length of screw thread as the nut; this follower is fitted with a "key," that prevents it turning in the recess, but allows motion in the direction of its length. A strong spiral spring is placed in the remaining half of the recess, between the fixed nut and the movable follower, and the spring has always tension enough to force the follower and fixed thread in contrary directions, and thus to remove any "lost motion" that may occur in the screw. It will be observed, that in this method the spring always remains in a state of rest, instead of closing and opening, as has been the case in all other applications of springs, and which have been the cause of their failure. Tangent screws that have had as much as 10′ play, have been made to work entirely taut by this method.

The mode of attaching the tangent screw to the plates in this instrument is entirely new—it is a miniature modification of the "Gimbelling" of a ship's compass, and allows the tangent screw, by its free swivelling, to be tangent to the plates in every part of its length, and thus never to bind. This tangent screw is also of value for sextants, astronomical instruments, &c., where lost motion is detrimental, and a smooth, easy motion is required.

In all instruments, the brass cheeks in which the three legs of the tripod play, are fastened to the lower parallel plate by a number of small screws, commonly twelve. When the legs wear in the cheeks, and become unsteady, the only method the Engineer has of tightening the legs, is by drawing the cheeks, in which the leg moves, by means of the bolt that passes through the leg; this, of necessity, draws the cheeks out of perpendicularity, and strains the small screws that bind the cheeks to the parallel plate so much, as frequently to loosen them. This source of instrumental error hardly, if ever, occurs to the Engineer, but very good instruments have been condemned as unsteady, when an examination has shown the fault to be the above. This source of error can never occur in this instrument, as the cheeks and the parallel plate are made in one solid piece.

But to come to the last and most serious evil. The effective power of the Telescope is impaired by spherical aberration; that is, the field of view, as seen in the Telescope, is not a perfect plane or flat, but is spherical. To prove this, take an ordinary telescope, and focus it so that an object will be clearly defined at the intersection of the cross hairs or the centre of the field of view, then, by means of the tangent screw, bring the same object to the edge of the field of view and it will be found in

every case to be indistinct and not in focus; on the contrary, focus it so as to be distinct at the edge, and it will be indistinct when brought to the centre. In some telescopes, however, it is impossible to focus at the outer edge of the field, and objects will be tinged with prismatic colors, showing that these glasses are affected by chromatic aberration also; sometimes the cause of this defect lies in the object glass, but in the majority of cases, the lenses composing the eye-piece are in fault.

These aberrations affect the working of the telescope in several ways. First, it practically diminishes the size of the object glass, and the view is never so clear and distinct as it ought to be. Second, It is very difficult, and in some cases almost impossible, to adjust the eye-piece to prevent parallax, or "travelling" of the cross wires, when the eye is shifted from side to side; and practical engineers know what a sharper power of defining, and how much less trying to the eyes a "soft glass" has—that is, one that has a "flat field."

This defect has prevented the general use of the Stadia, or Micrometer wires, as a method of measuring distances without a chain, as the two horizontal hairs that are used, being in diffrent parts of the field of view, can not, in a majority of cases, be focused so as to be devoid of parallax, and the slightest travelling of the wires in this operation will give an erroneous result.

The evils of this defect were most forcibly brought to Mr. Heller and the late Wm. J. Young's notice, when one of their best Transits failed to define in tunnel work, from loss of light, from this cause, and they both endeavored, to within a short time of Mr. Young's death, to remedy it, trying all the known formulas of almost all the opticians in the country, but without any good results.

In the Telescope of this instrument these evils are entirely removed, by the employment of a new eye-piece, and advantage has been taken of the improvements that Optics have made in the last few years, in the curvatures and arrangements of the lenses that compose it; and the test referred to above, of focusing an object in the centre of the field of view, and then bringing the same object to the edge, and it still remaining in sharp focus, can be done with this telescope, and the object shows no tinge of prismatic color, showing that both chromatic and spherical aberration have been removed.

The advantages of this improved Telescope are: a clear and sharply defined field of view; a field of view so flat that the cross hairs are without parallax in every part of it, and micrometer hairs or Stadia can be used with favorable results.

The whole effective power of the object glass being used and none of the light lost, work can be commenced earlier in the morning and continued later in the afternoon than is usual. This, in the winter season, is

no slight matter to the engineer, and lastly, there is no straining of the eyes in sighting.

The spider's web, by reason of its fineness, is the only article hitherto used for cross hairs, yet in use these have been attended with some difficulties: first, the spider's web is hygrometric, or is affected by the humidity of the atmosphere—when exposed to dampness lengthening, and of course throwing the line of collimation from its true place. This defect is more serious in the Engineer's Levelling Instrument than in the Transit, instances being known where the line of collimation has altered two or three times in the course of ten hours, by reason of atmospheric changes, and of course any observations taken at those times would be defective; lastly, the spider's web being a transparent and not an opaque substance, in some positions it is impossible to see the hairs at all—this is more especially the case when sighting in the direction of the sun; that is, an easterly course in the forenoon, or westerly in the afternoon.

To remedy this defect, platina cross hairs $\frac{1}{1000}$ of an inch in thickness, or as fine as spider's web, are substituted; these being opaque, and not transparent, in sighting in the direction of the sun are still visible, and any atmospheric changes, dampness, &c., do not affect them. We believe that we are the first ones in this country who have drawn wire so thin, and the only ones who have made any practical use of Dr. Wollaston's experiment. The platina hairs are invaluable in Mining and Tunneling Instruments, that are so constantly exposed to dampness, and being opaque, no reflector to illuminate the cross wires is required.

To prevent the stiffness of working of the leveling, tangent and other screws in cold weather, which arises from the congealing of the grease that is used in lubricating them, no oil is used upon the screws of this instrument, but they are lubricated with pure plumbago.

By a simple arrangement of the clamps on the axle of our complete Transits, we make them also answer the purpose of a pair of Compass sights, for taking offsets at right angles to the telescope.

From the above, it will be seen that this instrument has the following improvements over the ordinary Transit:—1. A simple, secure and steady method of attaching and detaching from the tripod, being the only long-centre transit made that detaches as easily as a short centre. 2. An important decrease of weight, without decrease of size, and an increase of steadiness. 3. All the working parts of the tangent screw, &c., brought within the plates, making the instrument more compact. 4. An improved tangent screw, telescope, cross hairs and tripod head. 5. A pair of sights for taking offsets; and 6. A new method of lubricating the screws.

On the relation of the AURORAS TO GRAVITATING CURRENTS.

By PLINY EARLE CHASE.

(*Read before the American Philosophical Society, May 5th*, 1871.)

Prof. Loomis's observations of the number of Auroras in each month of 1869 and 1870 (Amer. Jour. of Science, 3d S., i, 309), are specially noteworthy, both because of the careful accuracy of the observer, and because they are the first published observations which furnish satisfactory data for an approximate determination of the laws of auroral distribution.

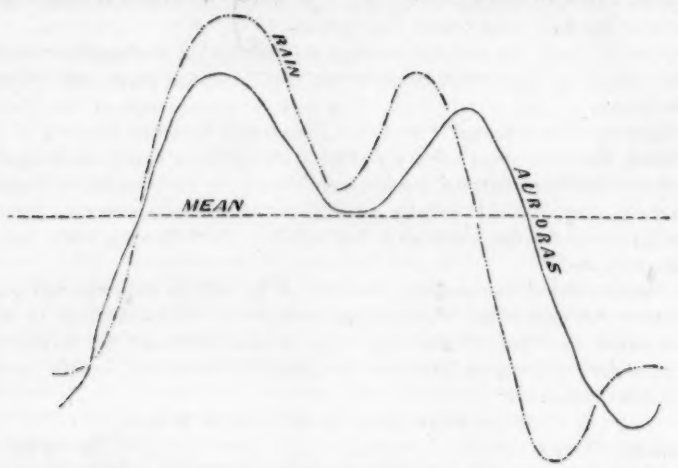
If the auroras are, as is now generally believed, luminous manifestations of terrestrial magnetism, it seems reasonable to look to them for some additional evidence upon the question of the relation between magnetic and gravitating currents. Messrs. Baxendell and Bloxam have already pointed out some resemblances between hyetal and magnetic curves, (see Proc. A. P. S., x, 368) and if analogous resemblances can be traced between hyetal and auroral curves, they will be interesting and suggestive.

I have not found the similarity between the annual distribution of rainfalls and of auroras, sufficiently striking to impress any one who has not made a special study of the causes of resemblance and difference. But, as I have repeatedly urged, currents are subject to an increased number of disguising disturbances, in proportion to the sluggishness of their motion, and the time which is consequently required for their formation or change. We may very reasonably look for analogies between the daily and the annual auroral or magnetic curves, of a character for which we could hope to find no parallel in wind, rain, or ocean-current curves.

If we desire, therefore, to find evidence of the joint influence of solar expansion and gravitating equilibrium, we should look where it is most likely to be found, and to the best of the observations which may be supposed to be fairly comparable. There are similar variations of solar attitude, and consequently increasing and diminishing solar force, in the day and in the year, but the effects of these variations upon the precipitation of vapor, are more likely to be shown in their greatest simplicity, by the means of observations at different hours of the day than at different seasons of the year. I know of no published observations of this character at New Haven, but there are some extending over a long series of years, at Philadelphia and at Greenwich, the curves at each station indicating minima of rainfall at noon and midnight, and maxima in the morning and evening. The difference of longitude between Philadelphia and New Haven being less than $2\frac{1}{2}°$, it is not likely that there is any material difference in the daily rain-curves at the two places.

In order to make the curves fairly comparable, both in regard to the times and the magnitudes of deviation, I treated the auroral observations in the same manner as those of rainfall (Proc. A. P. S., x, 526). Both in the magnetic and in the hyetal phenomena, the greatest effects accompany the greatest atmospheric changes. But in the magnetic disturb-

ances the principal maxima occur in the spring of the year and the morning of the day, while the general evaporation is increasing, whereas, in the daily rains at Philadelphia, the principal maximum occurs in the afternoon, when evaporation is diminishing. I have, therefore, compared the midwinter ordinate of the auroral with the noon ordinate of the rain curve, and the midsummer auroral with the midnight hyetal ordinate.



The auroral observations and the normal ordinates of the accompanying curves, are given in the following table. I presume no one will doubt that the condensation of vapor, which is represented by the rain curve, is occasioned by the simple operation of gravitation in blending currents of different temperatures, and I see no reason for postulating any different law for the development of electricity and magnetism in the aurora.

Comparative Table of Auroras and Rainfalls.

Mo.	No. of Auroras.	Normals.	Hours.	Normals of Rain.	Mo.	No. of Auroras.	Normals.	Hours.	Normals of Rain.
		88	0	91			100	12	103
January	32	90	1	91	July	38	101	13	106
		94	2	93			103	14	109
February	31	98	3	98	August	34	105	15	108
		103	4	105			107	16	104
March	41	107	5	110	September	43	106	17	98
		109	6	113			103	18	92
April	44	109	7	113	October	38	100	19	87
		108	8	112			95	20	85
May	36	106	9	109	November	27	91	21	87
		103	10	105			89	22	90
June	31	101	11	102	December	30	87	23	91

Winds of Europe.

By Pliny Earle Chase.

(*Read before the American Philosophical Society, June* 16, 1871.)

In my desire to give proper weight to considerations which favor the hypothesis of normal cyclonic currents, I stated in a recent communication to the Society (March 17, 1871), as one of the admitted facts, "that most of the European winds are cyclonic."

Further study has satisfied me that this admission is altogether too liberal, and that, although a majority of the European winds are cyclonic, the majority is not a large one. The daily weather maps of the French "Bulletin International," and the Quarterly Weather Reports of the British Meteorological Office for 1869, seem to show conclusively that in France and Great Britain, anticyclonic are nearly as frequent as cyclonic currents, and that it is only by a discussion of continuous records that the prevailing cyclonism, such as is indicated in the following table, can be demonstrated.

I have deduced the average direction of the winds from the tables in Coffin's "Winds of the Northern Hemisphere." Those marked (C) were computed by Prof. Coffin; the others were obtained by combining, with some regard to weight, the observations which he records for the respective districts.

Mean Direction of European Winds.

Ireland, (2 stations)	N.	86°50′	W.
England (C)	S.	66	"
Scotland, (C)	"	62	"
Sweden, (C)	"	50	"
Norway, (1 station)	"	86 59	"
Denmark, (C)	"	62	"
Denmark, Norway and Sweden	"	62 56	"
Russia	"	52 21	"
" and Hungary, (C)	N.	87	"
Prussia	S.	73 36	"
Germany, (C)	"	76	"
" Southern, (C)	"	82 4	"
Austria	"	64 49	"
Holland and Belgium	"	79 13	"
France and Netherlands, (C)	"	88	"
France, (C)	"	82 50	"
Switzerland	N.	56 54	"
Italy	"	26 43	"

On the Normal Position of the Tidal Ellipsoid.

By Pliny Earle Chase.

(*Read before the American Philosophical Society, June* 16, 1871.)

The inferences of Laplace, that for certain depths, and of Airy, that for all depths, on a globe covered with a sea of uniform depth and without

friction, it should be *low water under the moon*, rest on the assumption that ∂r is so slight (see Mec. Celeste 327 iv, 337 iv, 342, 2177, &c.,) that it may be neglected, in order to satisfy equations which would otherwise be impossible of integration. It is true that the radial coördinate of the tide wave, is insignificant in comparison with the coördinates in latitude and longitude, but the cause of that insignificance is not immediately evident, and I can see no reason for omitting, in tidal discussions, any term which would be important in the discussion of planetary motions.

I presume the following postulates will be readily granted.

I. If the earth had no axial rotation, the tide would be one of equilibrium, with high water under the moon.

II. If rotation were to commence after the establishment of the equilibrium tide, the tidal ellipsoid would be thrown forward in the direction of rotation.

III. If the water flowed with such velocity as to be self-sustained, the centrifugal balancing the centripetal force, it would be low water under the moon.

As neither the first nor the third of these conditions is true, it would seem reasonable to infer that the tidal crest should be at some point intermediate between the lunar meridian and the lunar astronomical horizon. The second postulate favors this inference, provided there is any force, other than friction, which would tend to set back the crest of the third postulate.

Such forces, it seems to me, exist in the cohesive attraction and incompressibility of the water, and the rigidity of the earth, all of which tend to shorten the radius vector and increase the velocity of every particle dm, in two of the quadrants, and to lengthen the radius and diminish the velocity, in the alternate quadrants. These successive increments and decrements of velocity terminate at the octants, thus tending to produce low water three hours before, and high water three hours after, the moon passes the meridian.

Airy (Mo. Notices, R. A. S., April 13, 1866), gives a diagram to show, from the position of the points at which *zero* horizontal currents become *plus* or *minus* currents, that it must be low water under the moon. I am unable to reconcile his hypotheses, respecting the direction and velocity of the currents, with actual tidal observations, but even if they are correct, I think we should look to the total action of the moon, rather than to the flow of water at particular points. The water falls in the entire quadrants immediately following, and rises throughout the quadrants immediately preceding the meridian of high water. Would not this continuous action be best sustained if the moon were on the great circle 45°W. of the crest and 45°E. of the trough of the tidal wave, as Newton suggested in his *Principia*, B. I., Prop. 66, Cor. 20?

Note on an Apparent Violation of the Law of Regular Progressive Debituminisation of the American Coal Beds Coming East.

By J. P. Lesley.

(*Read before the American Philosophical Society, June*, 1871.)

In the course of a Geological survey of certain lands in Somerset County, Pennsylvania, it appeared that the beds of coal existing at Ursina held much less volatile matter than was expected. The gas coals of Westmoreland County, which come east as far as Connellsville, only thirty miles west of Ursina (see accompanying map), hold between 30 and 40 per cent. of volatile matters. Three analyses show the Ursina coals to have but 17 per cent., while a fourth gives 22 per cent. This puts the Somerset County coals into the *semi-bituminous* class. Yet the specimens were taken from gangways, a good many years old, and several hundred feet from the outcrop, under high hill cover, at a point on the *western* border of the First Bituminous Coal Basin of Pennsylvania, near the Maryland and Virginia State line. More properly we should say that the Ursina coals lie in the second synclinal of the First Basin. For the Negro Mountain Anticlinal comes up from Virginia and splits the First Basin into two in Pennsylvania. The mountain dies down at Castleman's River; but the anticlinal axis runs on northward. The First Basin is similarly split into two, east of Johnstown, by the Viaduct Anticlinal, which may or may not be an actual prolongation of that of Negro Mountain.

To make the situation understood, the following extracts from my report to the owners of the property will suffice. The accompanying map shows the Backbone of the Alleghany passing by Altoona. This is the eastern edge of the First Bituminous Coal Basin. The two long parallel mountains between Ursina and Connellsville enclose the Second Bituminous Coal Basin of Pennsylvania. The Third, Fourth, and Fifth lie west of it, and the Sixth occupies the northwest corner of the map; no mountains separating the last four.

Figs. 1 and 2 will suffice to show the topographical character of the country, and how the areas of the almost horizontal coal beds have been cut out into patterns, as if with a jig-saw, leaving outcrop edges around all the hillsides, at which gangways enter, and from the mouths of these shutes depend.

Figs. 3 and 4 give vertical sections of the coal measures made with Becker's Barometer; and Figs. 5 and 6 show longitudinal Vertical sections of the hills.

Special surveys like this have more than a commercial value: they reveal, sometimes very unexpectedly, new truths for men of science. It is an advantage to have them placed on record for common use. Too many of the collected facts of science are annually lost for want of publication.

The property surveyed in this instance, lies in my old tramping and camping ground of 1840, during the fifth year of the State Geological

Survey. The report which Mr. James T. Hodge and myself made to Mr. H. D. Rogers, Chief of the Survey, may be found recorded in the Fifth Annual Report (1841), pages 89–92, which I will here recapitulate in the *descending* order of the beds, for convenience of comparison.

The Pittsburgh bed, I, has been eroded from the whole country between the Alleghany Mountain and Chestnut Ridge (at Connellsville and Blairsville) except two hill tops; one, near Salisbury, and the other near Ligonier. It is possible also that a third exception may be discovered in the high hill country south of Johnstown, where a conspicuous bench runs along the hilltops for several miles.

Limestone, 20 feet below I, 6 feet thick in the Ligonier Basin.

Coal bed H, 50 feet below I, 3 feet thick in the Ligonier Basin; 1 foot thick in the Salisbury Basin.

Coal bed G, 100 feet below H, 1½ feet thick in the Salisbury Basin; encircles the highest hilltops in the Ursina Basin with a conspicuous bench. Fort Hill is not quite high enough to have it.

Red Shales between G and F.

Coal bed F, 90 feet below G; generally small; but 4 feet thick in the Salisbury Basin. It forms the high terrace of the Fort Hill.

Mahoning Sandrock.

Coal bed E, "Upper Freeport," 50 feet below F; 2 feet thick, on 2 feet of *Limestone* (over it Shales with *ore-balls*) in Ursina Basin; 3 feet thick, on 5 feet of *Limestone* in the Salisbnry Basin.

Coal bed D, "Lower Freeport," 60 feet below E, 6 feet thick in Ursina Basin; 4 feet, further north; over 10 feet of Sandstone with *ore balls*, in two beds, 7 feet asunder, 11 inches in all. This ore ball horison is very extensive north and south of the River.

Coal bed C, 20 feet below D, 2½ to 4 feet thick.

Coal bed B, 30 feet below C on Cox's Creek, 40 on Laurel Hill Creek (N. Fork), and 60 at Confluence; 4 feet thick over 8 feet of *Limestone* on the river; 1½ feet thick over 4 feet of *Limestone* on the North Fork. Twenty feet above B lie 15 feet of Shales, etc., containing *ore balls*, on Spring Run, below Pinkerton's Bend of the river.

Coal bed, 22 feet below Limestone, on west bank of Castleman's river, ¼ mile above Zook's run ford, and on North Fork at old salt boring; carries 5 feet of Shale containing 1 foot of *ore balls*.

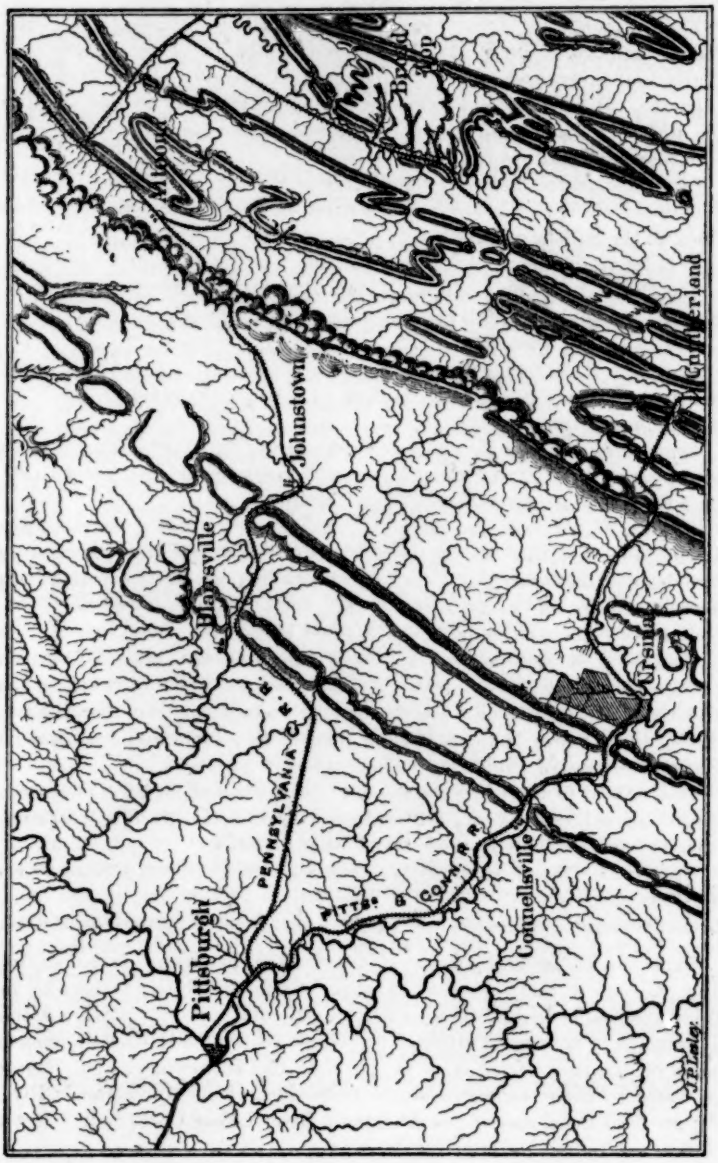
Coal bed A, 70 feet below B; 22 inches thick, at Shroff's Bridge over Castleman's river.

Conglomerate; 30 feet below A; the interval being massive Sandstone.

Such was the general scheme of the Coal measures made out during the old survey, and, however subsequently modified, it has been of incalculable value in all subsequent special, and private investigations. It was a very successful attempt to reduce to system the heterogeneous mass of details collected from all parts of the Bituminous Coal Region of western Pennsylvania outside, or to the east, of the Monongahela River Upper Coal Beds, and of the Alleghany River Lower Coal Beds. It was

A MAP

Showing the Geographical Relations of the Pittsburgh and Baltimore C. C. and I. Co.'s Lands to the surrounding county.



by the collation of these three generalizations, that the first knowledge of the true order of the American Coal Measures was obtained, a starting point and a basis for all the Western Surveys.

It was merely a sketch, however; done hastily, in a single season, and with most inadequate means at our command. In pecuniary power the party fell so low that one of our camps on the North Fork could not be moved, because the whole party could not raise, amongst them all, 37½ cents to pay a farmer's bill for potatoes. A messenger was dispatched to Hanna's at the Turkey-foot, now Confluence, with a faint hope of receiving from the Chief in Philadelphia a remittance. Happily a letter was lying in the Post office which relieved our embarrassments.

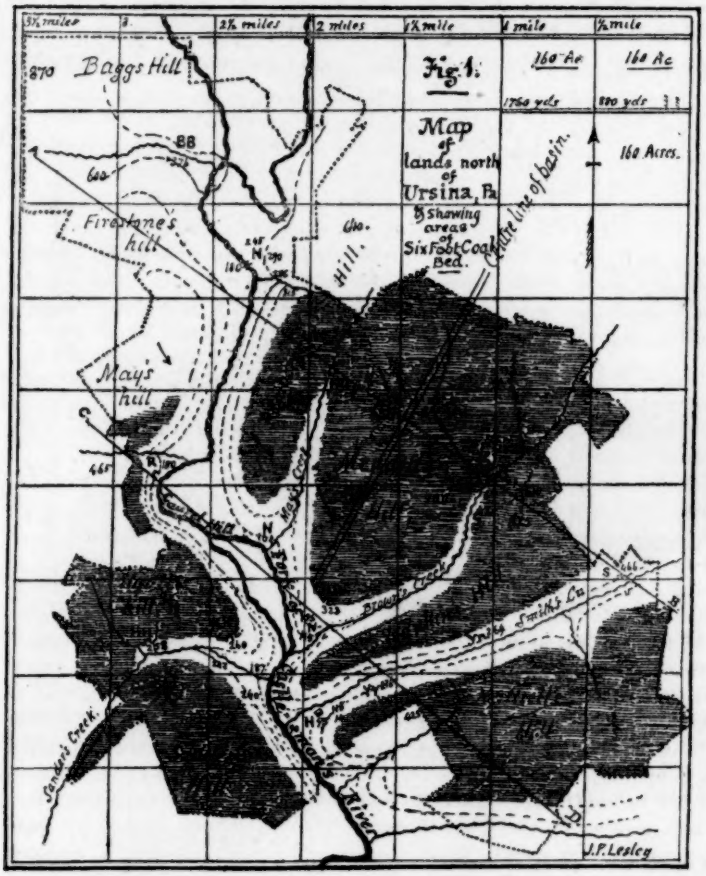
Every subsequent private survey has revealed both the general accuracy and the special inaccuracies of the summary statement of the Fifth Annual Report; and there is work for competent local geologists for a long time to come, tracing the principal members of the column, observing their variations, intercalating the more insignificant deposits, and discovering their sudden, and local, and valuable expansions. We know but little yet of the true nature of the genetic relationships of coal, carbonate of lime, and carbonate of iron. But we know that they hold some curiously fixed relationships of the highest economical importance. Every special survey, therefore, should be published, in the hope of taking another step towards a complete understanding of that subject.

It is with this view that I append a special description of a property recently surveyed, stretching for five miles along the North Fork of the Youghiogheny. The North Fork is the Laurel Hill Creek of the Fifth Annual Report. Its mouth and that of Castleman's river makes the Turkey Foot at Confluence. Ursina is a new village one mile up the Fork. The new Baltimore and Pittsburgh Railway is constructed up the south side of the Fork past Ursina, where its grade is 90 feet above water level. It then passes (by a tunnel) through the hills, and continues its course eastward up the North bank of Castleman's River. Ursina is 86 miles by railroad from Pittsburgh, and 243 from Baltimore. There are 6436 acres in this property, and its greatest width of two miles carries it across the centre of the Coal Basin so as to include both dips; which, however, are very gentle, nowhere exceeding 5° and seldom as high as 1°. There is also a gentle lowering of the central belt or axis of the basin southwestward towards the Turkey foot, which has determined its strikingly romantic topography. The hills of nearly horizontal coal measures are 300 to 400 feet high, and the coal beds, etc., pass through them from valley to valley cropping out in nearly horizontal lines along their sides and around their ends. Easier conditions for mining cannot be imagined. And it is in a country quite destitute of faults.

The coal beds belong to the upper part of the Lower Coal System.

The Six Foot Coal Bed outcrops on the hill-side, over the town of Ursina, at an elevation of about 200 feet above the water. Its outcrop keeps at about this height along the east flank of the Ridge (Minder's and Sander's hill) for two miles, up the west bank of the North Fork. It crops out on both sides of Minder's creek, as high up as the forks, where it gets under the water of the run, which descends rapidly.

Fig. 1.—A MAP SHOWING THE AREAS OCCUPIED BY THE SIX FOOT COAL BED IN THE HILLS NORTH OF URSINA.



In the northern part of the property it outcrops on both sides of the

North Fork, at the same elevation of about 200 feet above water-level, for a distance of two and a half (2½) miles ;

—Along both sides of Smith's creek, for 1¾ miles :

—Along both sides of Brown's creek, for 1¼ miles :

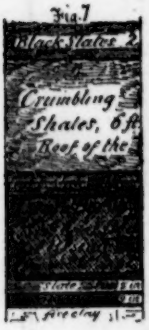
—Along both sides of May's creek, for ¾ mile :

—Along both sides of Sander's creek, for ½ mile :

So that the outcrop of this bed has a run of over ten (10) miles.

In this Northern part of the property it lies also in the best manner possible for mining ; falling gently in all directions towards a central point, or mining location, between the mouths of Smith's and Brown's creeks. The arrows on the map (fig. 1) show the direction of the fall of the coal. The two parallel lines (from R R northeastward) show the central axis of the basin, or deepest part of the coal bed, falling towards S. 30° ± W.

Down this central axis the coal bed falls at the rate of less than 1° ; or, between 60 and 70 feet in the mile. The *fall* from the Krieger bank to the Rose bank, W. S. W. is 150 feet in a little less than a mile. The *rise* from the Rose bank to the crop, up May's creek, northward, is 120 feet in a little over a mile.



The following openings on this Six Foot Bed have been worked for several years :—

The Krieger Bank one mile up Brown's creek, south side ; 9 feet above the water-bed ; runs in 109 yards, E. 10° S. ; coal mined from several small breasts, not many tons altogether. It is represented in Fig. 7.

Top Rocks : Black Slate	2 feet.
Crumbly Shale	6 feet.
Top coal, with three half inch slates	1 foot.
Main coal, solid bench, with occasional wedges of drab clay	5 feet.
Slate not taken up	8 inches.
Bottom coal, bench not taken up	9 inches.

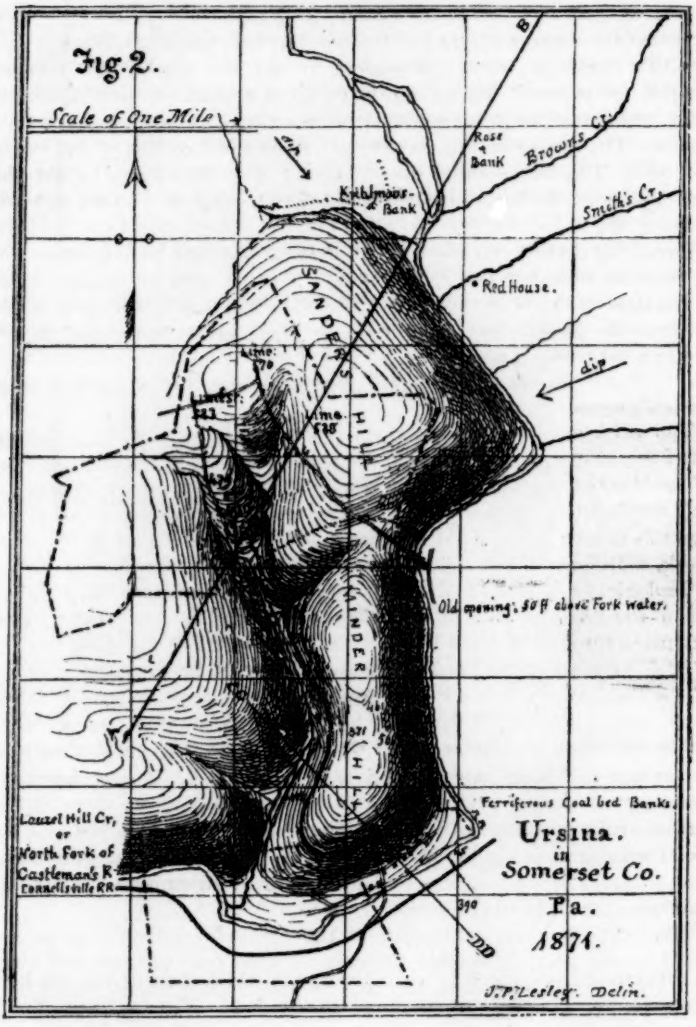
The following analysis by Mr. Persifor Frazer, Jun., shows a superior percentage of solid carbon with a minimum of ash, sulphur and water :—

Carbon (coke)	79.25 (or ⅘ of the whole.)
Volatile substances	17.17 (It is therefore not a gas coal.)
Ash	3.11 (an extraordinarly pure coal.)
Sulphur	0.47
Water	0.55
Total	100.55 :

in which the sulphur has been considered exclusively a constituent of the Ash. The specimen (No. 1) was obtained from the Krieger bank, some distance back in the gangway, and midway of the bed, between the roof and floor, and may be considered a fair specimen of what the bed will do when mined on a large scale.

A MAP showing the Topographical Character of the Southern part of the Lands of the Pittsburg and Baltimore Coal, Coke and Iron Company.

(*Reduced by Photolithography.*)



The ash is remarkably small—the coke very great (nearly $\frac{4}{5}$ths of the whole); and the gas no higher than in Broad Top Coal; water and sulphur about half of one per cent. The small percentage of water in these coals is remarkable.

The coal is friable and comes out much crumbled, and will not bear transportation, but makes a very nice grey even coke. The crumbling shale roof will call for very careful mining and abundant timbering to keep the mine in good order. But while timber is abundant in the district, longwall mining will let the roof fall behind and afford plenty of slate stuff for gobbing up, where needful.

The Rose Bank, opposite the mouth of Brown's creek, facing south, 220 feet above water; shows six feet face of coal, very good, except that there are a few thin layers of slate in the top bench of 12 inches, as before; a coal of 8 inches is said to underlie the bed, as before; roof, again, crumbly shale; coal very friable; it is roughly coked in the open air in front of the mine and makes good coke.

The Kuhlman Bank is opposite to the Rose, on the west side of the valley; and an old mine is $\frac{3}{4}$ mile further west on the same outcrop, and at the same level, 25 feet above the bed of Sander's run. Both are fallen in. The people say that the bed exhibited the same character as on Brown's creek.

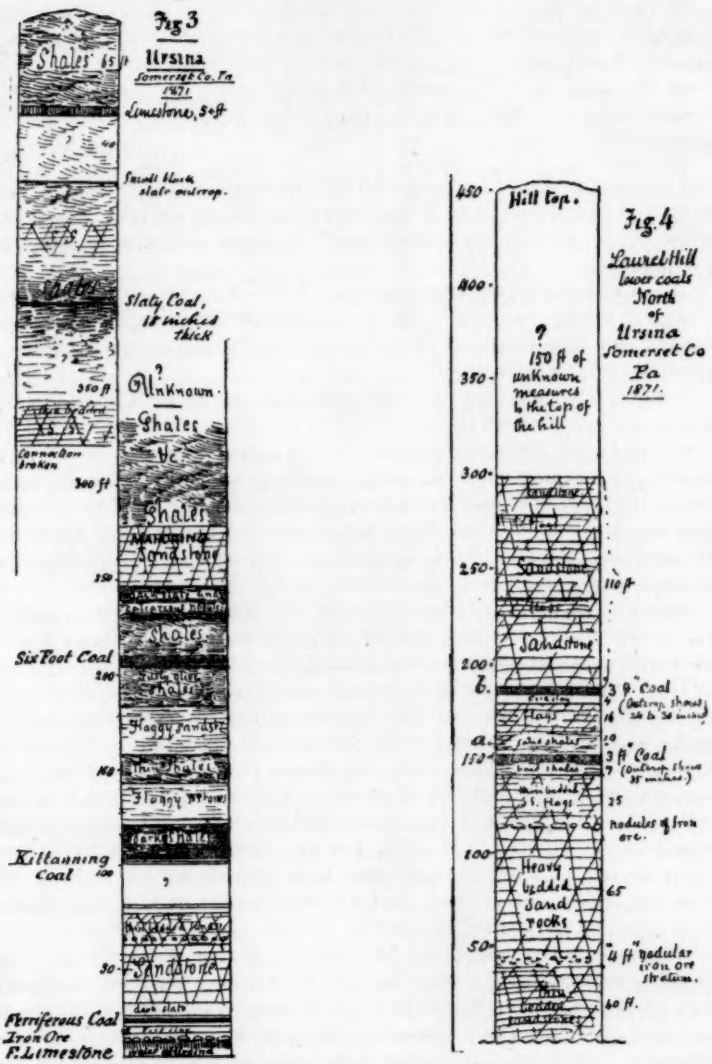
The bed has not been fully opened at the southern end of the property, but I see no reason why it should differ in quality or thickness here from where it is opened further up the North Fork, since it runs with remarkable regularity of thickness and character from the Krieger bank (up Brown's creek), to the Kuhlman bank and the old opening on Sander's creek, a distance of two miles.

Geologically, this bed is the continuation southward, into Maryland, of one of the Freeport beds of the Alleghany River System, having a wide extension through western Pennsylvania, and usually furnishing the best of coal. For want of special instrumental surveys in the country south of the Conemaugh, it is not now possible to assert positively to which of these two Alleghany River Coal beds the Six-foot coal, in southern Somerset county, answers best. Our best guide, the great lime rock which underlies the upper of these beds, thins out as it approaches the Allegheny Mountain and the Maryland line. But as we have a dark Shale, with limestone nodules, overlying our Six-foot coal bed, and beneath what is probably the Mahoning Sandrock, in the same position as that occupied by the upper of the two Allegheny River beds, the Six-foot coal would seem to be the lower.

If a colliery were established at the mouth of Brown's creek, and three incline planes ascended the ends of Younkin's hill, Menard's hill, and Hyatt's hill, then from the tops of these three planes, three main entries would have three unbroken coal fields straight before them, with a rising coal; in Youngkin's hill rising eastward; in Menard's hill rising northeastward, north northeastward and northward; and in Hyatt's hill rising west northwestward. The point is a rare one for large mining operations.

VERTICAL SECTIONS OF THE COAL MEASURES NEAR URSINA, SOMERSET COUNTY, PENNSYLVANIA, BY FRANKLIN PLATT, JR.

(Reduced by Photolithography.)



The gangway entering Menard's hill (at or near the present Rose bank), would command an unbroken area of one and three quarter square miles

of the Six-foot bed, containing the *gross* amount of.....10,500,000 tons,
and by tresseling May's and Brown's creeks at their upper parts where the bed is near their water level, mining might be carried forward into the Ramsbérger and Krieger area, and add..... 1,500,000 tons,
making in all.....12,000,000 tons,
commanded by this gangway.

The gangway at the end of Hyatt's hill, would command 2,250,000 tons,

The gangway at the end of Youngkin's hill would command..... 1,500,000 tons.

The amount of coal to be reached in the easiest possible way, and concentrated at one coal dèpot at the mouth of Brown's creek, is therefore evidently larger than the necessities of the largest collieries for an entire generation.

When the main gangways become inconveniently long, their air-ways along the outcrop will afford the most convenient outlets for slack and waste; and new gangways can enter any where, because the drainage of the mine will be perfect.

A fine colliery can also be established at the forks of Minder's Creek, a mile and a half above its junction with the North fork. Here the Six Foot bed strikes the water level of the run; gangways may be driven in horizontally west, northwest, north, northeast, and east, commanding an entire square mile of coal lands, or six million tons of coal. The tramroad for such a colliery will be, say 1¼ miles long, with a grade of 10, or between 90 and 100 feet to the mile, which may be lessened by judicious arrangements. This point has another advantage: it will permit *all* the Sander's Hill coal to come out, down grade. I never saw a more beautiful situation for a first class colliery on bituminous coal. Nor do I know of a better coal on which to establish a great coke trade.

The Turkey-foot is likely to become a second Johnstown, in the way of iron works, occupying precisely the same position, geographical and geological, upon the Baltimore and Pittsburgh through railway line, which Johnstown occupies on the Philadelphia and Pittsburg through railway line, as the map on page 3 will show; and just as Blairsville and Connellsville occupy precisely analogous situations, geological and geographical, to each other. At Ursina, the coal beds, iron ores, limestones occur in the hills in the same way that they do at Johnstown; the hills are of the same shape; and the minerals lie at the same angles with the horizon, and at similar heights above water level. At both places the Pittsburgh and Green county coal beds are absent, swept from the tops of the highest hills. At both places the blue carbonate iron ore of No. XI. underlies the conglomerate on the flank of the mountain near the top. And as Johnstown gets brown hematite ores from the limestone valleys of the Juniata, and fossil ore from Frankstown, and Lake Superior ore from Cleveland, to mix with the ores under the coal beds in its hills, so Ursina can get fossil ore and brown hematite from

HORIZONTAL SECTIONS OF THE COAL MEASURES NEAR URSINA, SOMERSET COUNTY, PA., BY FRANKLIN PLATT, JR.

(Reduced by Photolithography.)

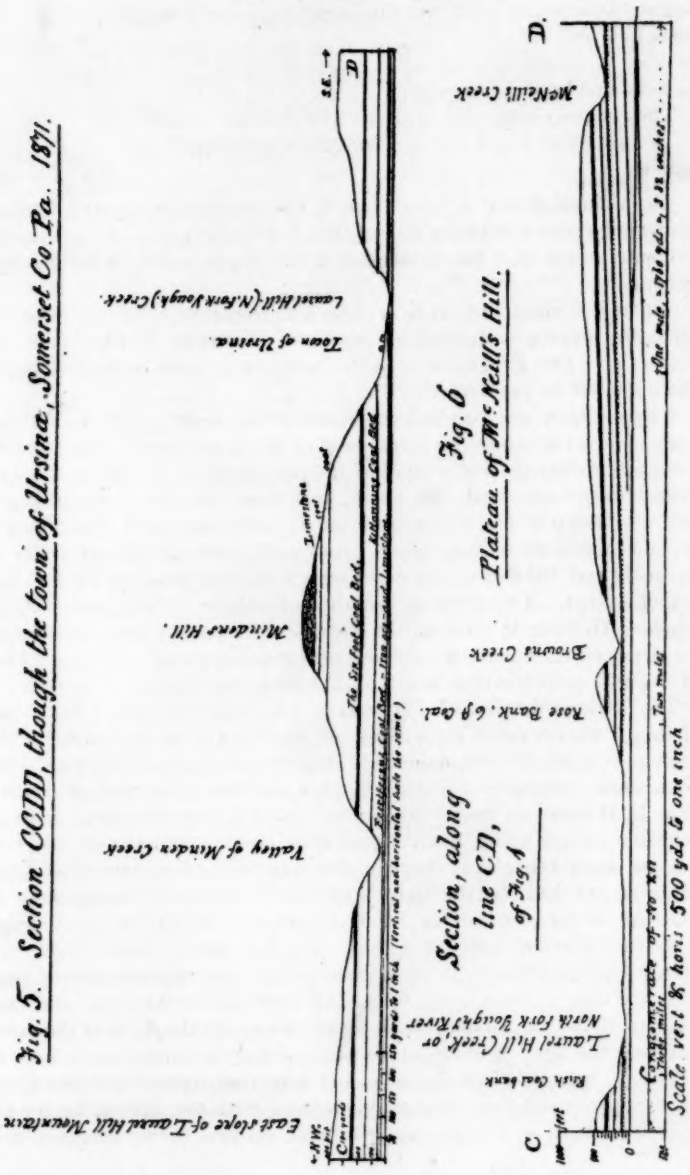


Fig. 5. Section CDD, though the town of Ursina, Somerset Co. Pa. 1871.
East slope of Laurel Hill Mountain.
Valley of Minden Creek
Minden Hill.
Town of Ursina.
Laurel Hill (N. Fork Young) Creek.
Fig. 6
Plateau of McNeill's Hill.
Section, along line CD, of Fig. 4
McNeill Creek
Brown Creek
Rose Bank, 6 ft coal.
Laurel Hill Creek, or North Fork Young's River
Rush Coal Bank
Scale vert & horiz 500 yds to one inch

Cumberland and other points on the Potomac, and the same Lake Superior ores via Pittsburgh, to mix with same iron ores which lie in the hillsides of Castleman's river and Laurel Hill Creek.

Two other coal beds range through the property. The Kittanning bed 100 feet lower down the hillsides than the six foot; and the Ferriferous bed, nearly at water level. Two other small seams of coal exist in the hill tops, belonging to the middle or upper part of the Barren Measures, under the Pittsburgh Coal Bed.

The Kittanning Bed averages 2½ feet, and is best opened at Ursina. This bed outcrops all around the hill sides, north of Ursina; but goes beneath water level of Minder's Creek, two-thirds of a mile up from its mouth. It outcrops all the way up the North fork.

A thirty inch coal bed is opened at the Rush Bank, 1⅓ miles above the mouth of Brown's Creek, (fig. 1), 25 feet above the water of the North fork (Laurel Hill Creek). This bed underlies the Six Foot about 100 feet, and is the Kittanning coal bed. It shows 30 inches of good hard coal, with 15 inches over it of slate mixed with thin coal seams, and a roof of soft shales, requiring careful timbering. Its floor is a massive sandrock, without a particle of intervening fireclay. The bed has only been stripped at its outcrop; but yields cubical masses of very firm coal.

This is the usual Cannel and Block Coal bed of the country.

The Ferriferous Bed, (so called, not because it carries, itself, any iron, but because it always comes into the measures just above a limestone which is called ferriferous because it carries on its upper surface the great iron ore deposite of north west Pennsylvania, especially in Clarion, Venango and Armstrong Counties), averages 2½ feet, and lies just above water level at Ursina. It sinks beneath water level going west, down the fork. It has been opened, also on the property, at the mouth of May's Creek, and at the mouth of Brown's Creek, on both banks of the creek. On the north bank 25 inches of coal is visible, with a 3 inch slate parting. On the south bank 20 inches of coal, 3 inches slate, 5 inches of coal; roof, 2 feet of iron-stained shales supporting 30 or 40 feet of sandstone; floor, hard slate; under this, a thick bed of fire-clay, containing nodules of iron ore; under this, limestone, said to be 18 inches thick.

The bed is not thick, but its quality of coal is good; the mineral coming out in solid blocks, and apparently adapted for the iron manufacture. Mr. Frazer has made two analyses of it, with the following results:

	No. 1.	No. 2.	Mean.
Volatile matters and water.....	17.12	17.13	17.125
Water alone.....	0.30		
Fixed carbon.....	68.20	68 87	68.535
Ashes.....	14.68	14.00	14.34

Another specimen taken from the Widow Croll's bank, near the mouth of Brown's Creek, shows the same character of this lower coal, above the limestone; equally free from water and sulphur as the Six Foot bed; more gas (equal to Alleghany Mountain Coal in this particular); a large quantity of ash; and 3-5ths of it coke.

Water	0.55
Volatile substances (Gas)	21.90
Carbon (Coke)	60.98
Sulphur (in ash)	0.62
Ash	15.95

The Ferriferous coal is opened also at the head of Smith's Creek, on both banks of the creek. On the south side a pile of half burned lime, shows how strongly ferruginous the limestone stratum is. On the north side, the outcrop exposed by digging, shows two feet of coal, the upper foot slaty; 1 foot of clay, with nodules of ore, in the roof; over this again 1 foot of sandstone; then one foot of dark slate; then a heavy sandstone. The floor is a thick bed of fireclay, the upper 3 or 4 feet being closely filled with nodules of iron ore.

At the base of the Ramsberger Hill and on Bogg's Creek, at the north end of the property, this coal, and another bed 30 feet below it, (see section fig. 4), apparently 24 to 36 inches thick each, and mixed with slate, occur again, and no lower measures are visible anywhere. The conglomerate at the base of the coal measures is just underneath them; the same which may be seen in the gap below Confluence, making a great arch in the mountain.

The fire clay under the ferriferous coal is usually about 4 feet thick.

The Ferriferous Limestone shows about 18 inches thick on the east bank of the North fork, but its general thickness I do not know. It is the same deposit which on the Slippery-rock and Beaver River country furnishes the *soda*-lime for the Pittsburgh works. On Smith's creek the farmers have tried to burn this limestone for use, but failed, and the calcined fragments show that it contains much iron, and may, therefore, make a superior blast furnace flux.

This bed underlies the country about water level, and is very consistent with the character given above. At Ursina it shows the same slate-parting near the bottom, and the same underlying beds of fire clay, iron ore and limestone. It will probably play an important part in the future development of the Turkey foot district.

A small (2 inch) layer of nodules of iron ore occurs about 65 feet above water level at Ursina, but it is, of course, worthless at this point.

A small coal bed outcrops 127 feet above the Six Foot bed, over the Krieger bank.

One of the limestones of the upper part of the barren measures comes in, between 475 and 525 feet above water level, near the summit of Minder's Hill, and extends through the hill tops of the property west of the North fork. It is at least 5 feet thick, and ferruginous.

About 100 feet below this limestone is a thin coal vein, very slaty, and good for nothing. There is also a bed of coal-slate 40 feet under this upper limestone.

The analyses given above are important. They oppose the law of *progressive bituminisation westward* of the coal beds.

That both the 6 foot and the 3 foot Ursina beds, situated at the western limit of the 1st Bituminous coal basin, should have only 17 per cent. of volatile matters,—not more than the coals of the Broad Top Region, lying one hundred miles to the east of Ursina,—is truly remarkable. The Broad Top beds are tilted and faulted abundantly. The Somerset County beds are almost perfectly undisturbed. The coal in one gangway showed 22 per cent. of volatile substances. But even this is no greater than the coals of the summit of the Alleghany Mountain, and the coals of the Cumberland Coal Region.

No proper scheme of the *rates* of *debituminisation* to *casting*, and to *disturbance*, can be obtained until all the analyses of each bed in the series of Coal Measures shall be tabulated apart from the rest. We may then expect to learn something also respecting the influence of specific vegetation upon the percentages of coke and gas.

But in the outset one source of error must be guarded against. The specimens of coal from which the foregoing analyses were made, were obtained in the walls of old gangways. It is possible that they had been long enough exposed to the air to lose some of their hydro-carbons by spontaneous evaporation. The rate at which this goes on in coal mined and exposed in heaps, is variously stated by those who have investigated the subject.

Dr. Richters made a recent communication to a German Journal, in which he states his opinion, that the weathering of coal depends upon its ability to absorb oxygen, converting the hydro-carbons into water and carbonic acid. At a heat, say of 375° F, only 5 or 6 per cent. of the carbon accepts oxygen, the rest seems to show little or no disposition to affine with it. The process is apparently dependent upon the per centage of hydrogen. But with coal, cold, or at ordinary temperature, the oxydation is so slow as to be imperceptible, even after exposure for an entire year. He says moisture has no accelerating effect, unless pyrites is present in quantity. Pure coal, heaped up for nine months or a year, unprotected by the weather and not allowed to become heated, is changed no more than it would be in a perfectly dry place.

Herr Grundmann, of Tarnowitz, on the other hand, has recently published elaborate experiments proving the effects of exposure on bituminous coals to be most serious. Coal which he exposed for nine months, lost *fifty per cent.* of its value as fuel. His conclusions excited such doubts, that his experiments were repeated, in connection with Herr Varrentrapp, of Brunswick, who proved, by laboratory experiments, that oxydation took place at common temperatures. Three months sufficed to rob coal, kept uniformly at 140° C. (284° F.) of *all its Carbon*, a heat less than that evolved in coal heaps exposed to the air.

Grundmann proved that the decomposition was the same in the middle of the heap as at the surface, and reached its maximum about the third or fourth week; that half of the oxygen was absorbed during the first fourteen days; that a coal poor in oxygen absorbs it most rapidly; that moisture is an important condition; that coals making, when freshly mined, a firm, coherent coke of good quality, make, after even only *eleven days'* exposure, either no coherent coke at all, or coherent coke of quite inferior quality. For gas purposes also, the coal is greatly injured.

It is evident that these facts have an important bearing on the value of the analyses given above.

Note on the TITANIFEROUS IRON ORE BELT, *near Greensboro, North Carolina.*

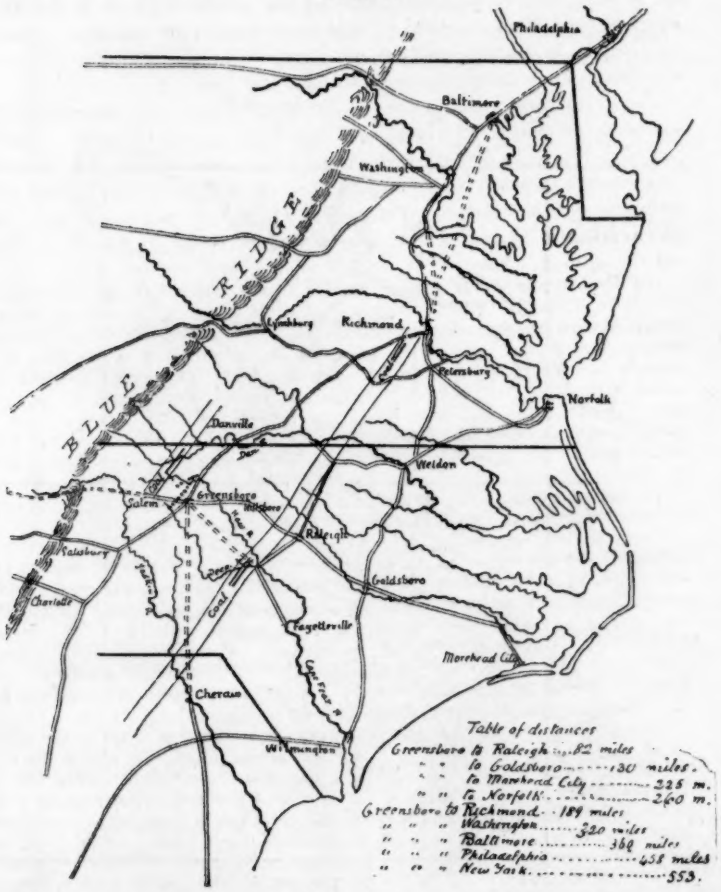
By J. P. LESLEY.

(*Read before the American Philosophical Society, June* 16, 1871).

I embrace the oportunity to exhibit the structure of this interesting ore belt, afforded by a recent survey of the lands through which it runs for thirty miles; lands owned or leased, by an association of gentlemen, known as the North Carolina Centre Iron and Manufacturing Company of Philadelphia, of which Mr. Thomas Graham is President.

The photolithographed cuts at my command, were reduced in fac simile, from my drawings, by Bien's process, and are sufficiently clear to ex-

FIG. 1.



hibit so much of the geology of the country as is necessary to the right classification of the ores in question. The chief interest which the ores

have for us, comes from the analyses given below. But the relations which these ores bear to other ores of similar composition, cannot be understood without a general description of the district.

Fig. 1, will inform those who are not acquainted with American geography, of the geographical relationship of the Greensboro district to the Atlantic sea-board and to the Blue Ridge Range of Primary mountains.

The two Triassic belts containing coal appear on this map; the eastern including the Richmond Coal Basin and that of Deep River; the western that of Dan River, prolonged northward across the James River below Lynchburg, and originally connected with the continuous out-spread of the Trias in Maryland, Pennsylvania, New Jersey, and the Connecticut Valley.

Fig. 2 gives, on a larger scale, the position of the ore-belt in Guilford and Rockingham Counties, N. C., and the radiation of railways, already running, or under survey, from Greensboro.

FIG. 2.

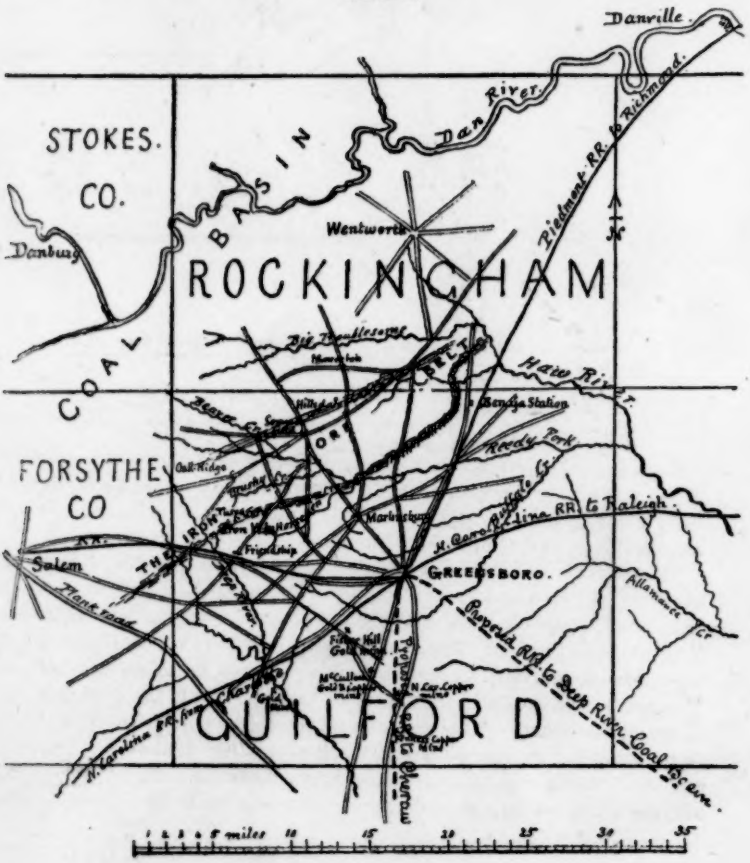
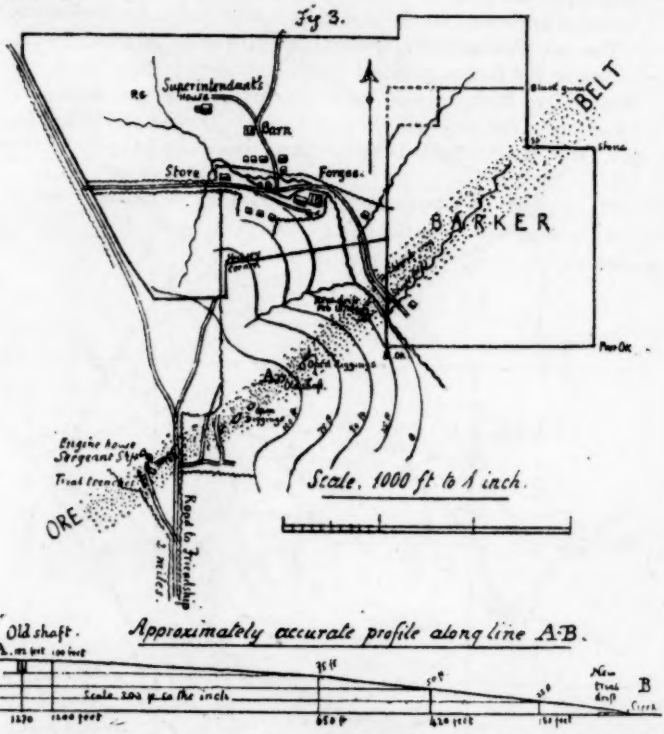


Fig. 3 is a special map of the ore-belt where it passes the Tuscarora forges, and has been most thoroughly tested. Here is the Sergeant shaft. The accompanying section will be of use, as it furnishes a carefully measured example of the numerous hill slopes which compose the surface of the country.



Figs. 4 and 5 continue the mapping of the ore-belt on to the head-waters of Deep River, to the southwest; and to the northeast as far as the Haw River. The general straightness of the outcrop for 15 miles, and more, is remarkable. The whole length surveyed was about 30 miles.

This part of North Carolina is occupied by some of the oldest rocks known; the same rocks which hold the iron ore-beds of Harford Co., Md., and Chester Co., Pa., and the gold ores of Georgia, North Carolina, Virginia, and Canada. The gold mines of Guilford Co., N. C., are opened alongside of, and not more than ten or twelve miles distant from, the Tuscarora iron ore-belt. See figure 2 above. Both the gold and iron range continuously with the exception of one break, in New Jersey, from Quebec, in Canada, to Montgomery, in Alabama. The gold and iron-bearing rocks are: granites, gneissoid sandstones, and mica slates, all very much weathered and decomposed; and that to a depth of many

FIG. 4.

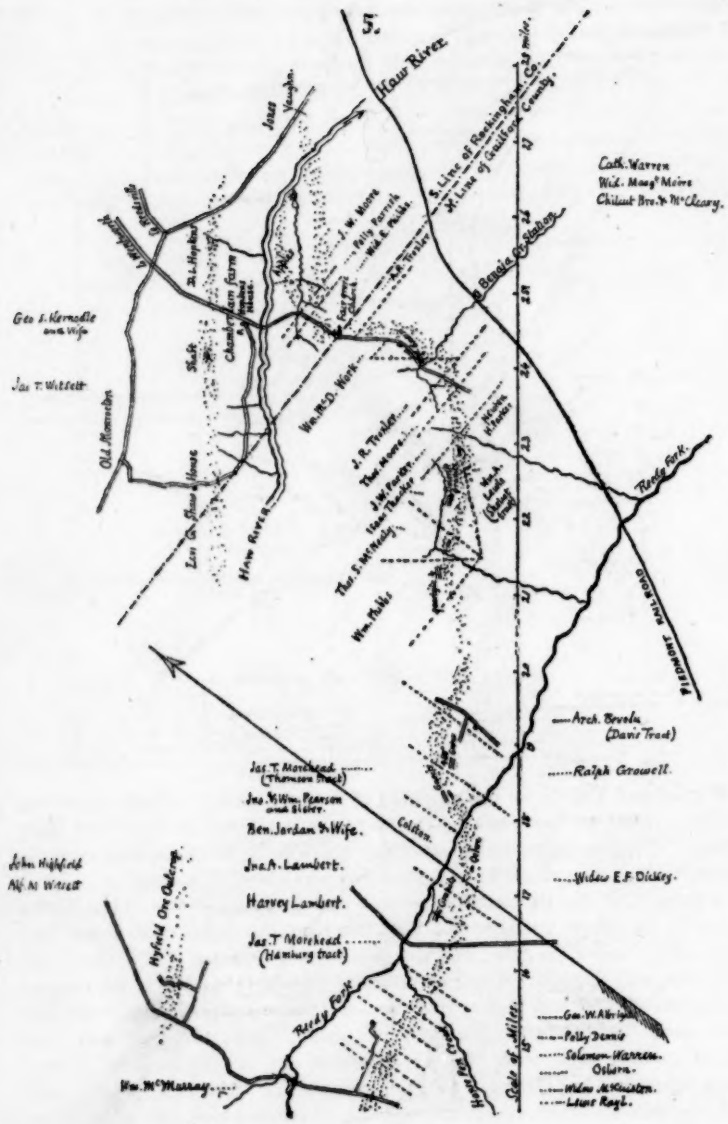
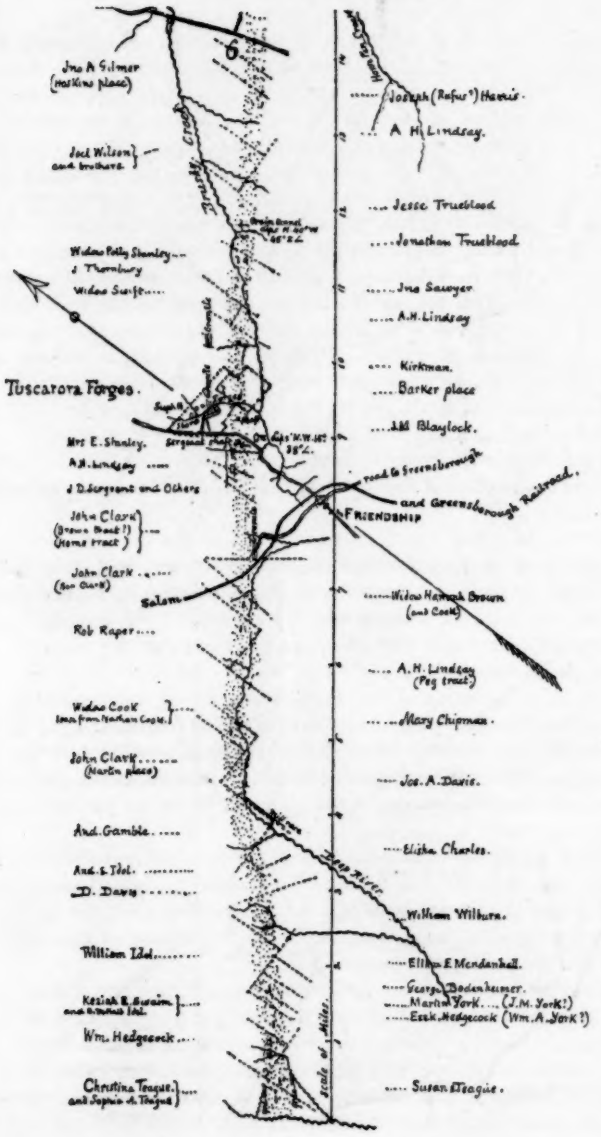

5.
Haw River
Cath. Warren
Wid. Marg't Moire
Chilcut Bro. & Mc Cleary.
Geo. L. Vernedle and Wife
Jas. T. Whitsett
Old Mansion
Haw River
Reedy Fork
Piedmont Railroad
Arch. Beverly (Davis Tract)
Ralph Growell
Jas. T. Morehead (Thomson Tract)
Jas. & Wm. Pearson and Sister.
Ben. Jordan & Wife.
Jno. A. Lambert.
Harvey Lambert.
Jas. T. Morehead (Hamburg tract)
John Hifield
Alf. N. Wirtz
Widow E. F. Dickey
Wm. McMurray
Gen. W. Alston
Polly Dennis
Solomon Warren
Others
Widow M. Winston
Lewis Rogh.

FIG. 5.


Jno A Gilmer (mill & kiln place)
Jack Wilson and brothers
Widow Polly Stanley
J Thornbury
Widow Swift
Tuscarora Forges
Mrs E. Shanley.
A.H. Lindsay
J D. Sergeant and Others
John Clark (Brown Back?) (Thomas tract)
John Clark (Son Clark)
Salem
Rob Roper
Widow Cook (now from Nathan Cook)
John Clark (Martin place)
And. Gamble
And. L Idol
D. Davis
William Idol
Keziah B. Swaim and A. Nathan Idol
Wm. Hedgecock
Christina Teague and Sophia A. Teague
Joseph (Rafus?) Harris
A. H. Lindsay.
Jesse Trueblood
Jonathan Trueblood
Jno Sawyer
A.H. Lindsay
Kirkman.
Barker place
Abl Blaylock.
road to Greensborough
and Greensborough Railroad.
FRIENDSHIP
Widow Hannah Brown (and Cook)
A.H. Lindsay (Peg tract)
Mary Chipman.
Jos. A. Davis.
Elisha Charles.
William Wilburn.
Elihu E Mendenhall.
George Bodenheimer.
Martin York. (J.M. York?)
Esek Hedgecock (Wm. A. York?)
Susan Teague.
Scale of Miles.

fathoms beneath the present surface. The solid granites are decomposed least; the mica slates most. All contain iron, which has been peroxidised and hydrated, in the process of decomposition of the whole formation, and dyes the country soil with a deep red tint. Or, more properly speaking, the surface of the whole country is streaked with belts of red and gray soil, following the outcrops of the more weathered and the less weathered beds. But, even in the gray belts, the solid granite, or gneiss, or sand-rock, seldom appears at the surface, although outcrops of them can here and there be found; and a number of these outcrops are designated upon the map, close to, and on each side of, the Tuscarora ore-belt outcrop. The surface of the country, therefore, is a smooth, soft, undulating plain, broken by gentle vales, the bottoms of which are never more than one hundred feet below the plain, and commonly not more than half that depth. The roads show how readily the rock soil absorbs water and dries off again. The soft, mouldered condition of all the rock strata, to depths of 50 or 100 feet, is therefore easily understood. But the rapidity with which the erosion of the land goes on is surprising. An old bridge, built a century ago, over a stream near the Quaker Meeting House, and of course several feet above the water, is now buried to a depth of 6 feet beneath the surface of its little meadow.

Two general results follow from this universal ancient rainwater decomposition of the surface of the country, to the depth of the deep valley drainage plane:—

1. All sulphur, &c., has been washed out of the ore-beds, leaving the ore remarkably pure. Whether the ore-beds, when followed down for hundreds of feet or yards into the earth, will be found to keep a notable percentage of sulphur, cannot now be known. But, whatever sulphur was originally combined with the iron, has been removed from the upper parts of the beds.

2. The decomposition of the rock strata, which inclose the ore-beds, has weakened them so that extra care must be bestowed upon all shafts and tunnels sunk or driven to win the ore, to keep them safe for mining operations. When the more solid strata, at various depths beneath the surface, are reached, mining operations will be as simple and safe as in any other region.

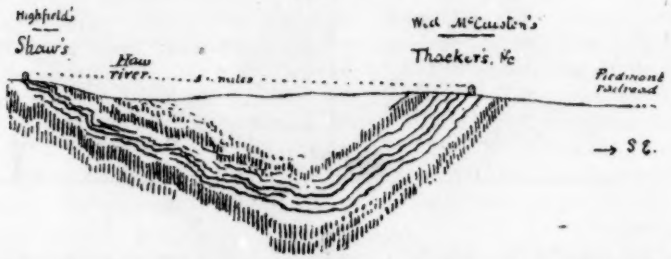
The hills being never more than about one hundred feet above the valley-bottoms, the ore-beds can be mined by horizontal self-draining adits, or tunnels, only at well selected points. But, seeing that the ore-beds run in straight lines for long distances, a large quantity of ore can be thus taken out, for some years to come.

The belt of outcrop of ore-bearing rocks has a uniform breadth of several hundred yards, and, I believe, a uniform dip towards the northwest, or north-northwest; although there are appearances (to be stated in detail hereafter) which would lead the casual spectator to conclude that the outcrop was double, and not single; that is, that the belt is synclinal, the ore-beds descending from the southeast side, downwards, northwestward to a certain depth, and then rising again to the surface. But the general

considerations against this view are so strong, that I reject it without much hesitation ; and I give my reasons further on.

The map, however, shows another ore belt running nearly parallel with the Tuscarora Forge Outcrop, and at a distance of three miles from it. This is called the Highfield, or Shaw Outcrop. Beyond the Haw River these two belts approach each other, and are believed to unite in Rockingham County. This, and other considerations, make it almost certain that the Shaw belt is the Northwest outcrop of a synclinal basin, three miles wide, and that the Tuscarora Belt is the Southeast outcrop. If so, the Tuscarora ore beds descend, with a N. W. dip, to a depth of a mile beneath the surface, and then rise again as the ore beds at Highfield and Shaw's ; thus :

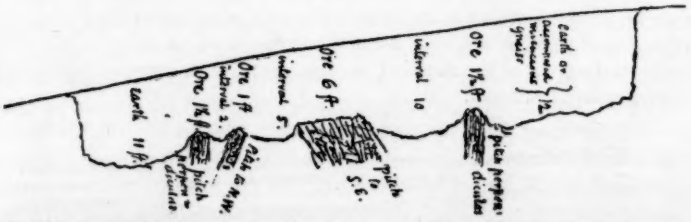
FIG. 6.



Many of the outcropping ore-beds are, to all appearance, vertical; others dip irregularly, some southeast, others northwest ; some steeply, others gently. But all these are extremely local variations, confined to a few feet or yards of depth, and will not invalidate the general uniformity of northwest dip of the whole Tuscarora Belt, and southeast dip of the whole Shaw Belt.

The following section of beds on (fig. 7) the Widow McCuisten plantation (14—15 miles), in a trench cut at right angles to the outcrop, 50 feet long, and from 4 to 8 feet deep, will illustrate these irregularities :—

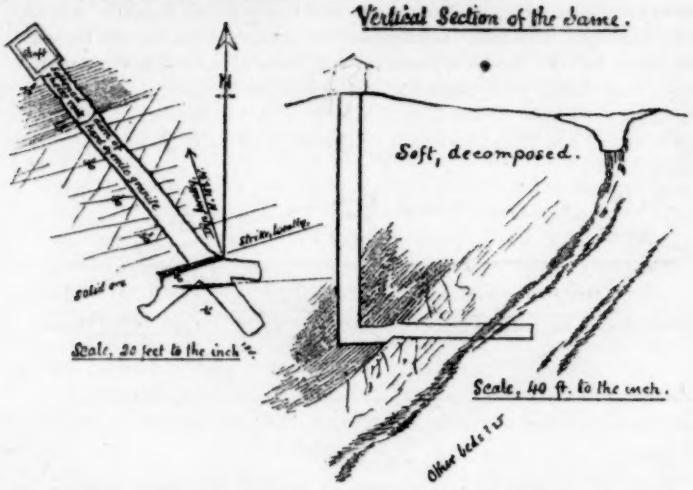
FIG. 7.



Similar irregularities are noticeable everywhere. The miners say that the pitch of the outcrop of the ore-bed worked in the Sergeant Tunnel and Shaft (9) was southeast for some distance down, after which it took its regular northwest dip, such as it now has in the shaft and tunnel at a

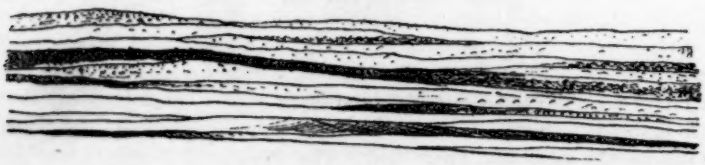
depth of 100 feet. Besides which, there are in fact two beds cut in this shaft-tunnel, the smaller bed underlying the other, and with a dip which would carry the two beds together at some distance beneath the floor.

Fig. 8 Ground plan of the Sargeant Shaft and Tunnel.



These ore-beds are not ore-veins; for they do not cut through the rocks crosswise. They have no well defined walls; they have no selvages; there is no gangue-rock different from the rocks on each side; they have, therefore, not been formed in crevices subsequently in a later age after the uptilting of the formation; they have neither been ejected volcanically from below, nor infiltrated aqueously from above, nor secreted chemically from the wall rocks; in a word they are not at all "veins." On the contrary they are "beds;" beds deposited, like the rest of the rocks, in water; deposited in the same age with the rocks which hold them; are in fact rock-deposites highly charged with iron; and they differ from the rest of the rocks of the formation in no respect, excepting this: that they are *more highly charged with iron*. I can best represent the facts of the case by an ideal diagram of the rocks of the ore-belt in their original horizontal position, somewhat thus:

FIG. 9.

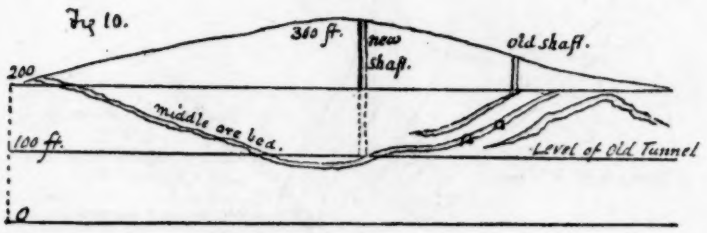


In fact all our primary (magnetic and other) iron-ore beds obey this law.

They are merely certain strata consisting more or less completely of peroxide of iron, with more or less intermixture of mud and sand, which, when crystalized, fell into the shape of feldspar, hornblende, mica, quartz, etc., etc.

To show that this is not mere theory, but actual fact, I compare here the section of magnetic iron-ore beds worked out on Durham Creek, near Easton, Pennsylvania, a map and sections of which can be seen by reference to W. Brook's part of the New Jersey Geological Report, by Prof. Cook, 1868, page 332, and given in Fig. 10.

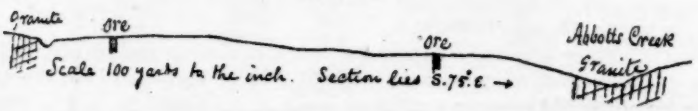
FIG. 10.



It follows then from the above mentioned facts:

1. That *the Number* of *Ore beds* in such a formation cannot be stated. A large number of rock strata will become ore-beds locally. But there will always be a particular part of the formation more generally and extensively charged with great quantities (or a high percentage) of iron than the rest. In other words, the iron of the formation as a whole is concentrated along one or more lines. This is evidently the case with the Tuscarora Ore Belt, as is shown by the almost perfect straightness of the outcrop of the Sergeant Shaft ore-bed, where its outcrop has been opened for half a mile northeast of the shaft. There are two principal beds cropping out on the Teague plantation, at the (southwest end of the belt), both vertical, and about 300 yards asunder, thus: Fig. 11.

FIG. 11.



Another instance occurs on the Trueblood plantation (12 miles), where the two ore-beds appear to be only about 200 yards apart at their outcrops, and seem to dip different ways, which I explain by reference to the false surface-dip of the Sergeant Shaft bed. The Trueblood section is as follows:

FIG. 12.

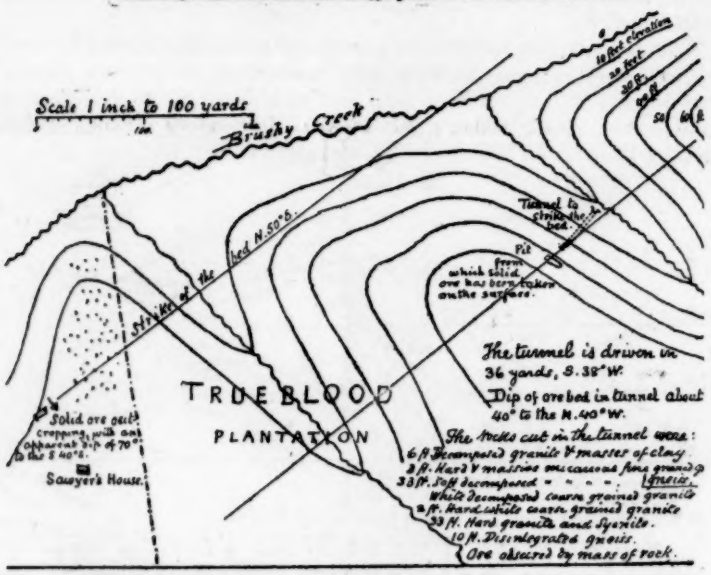
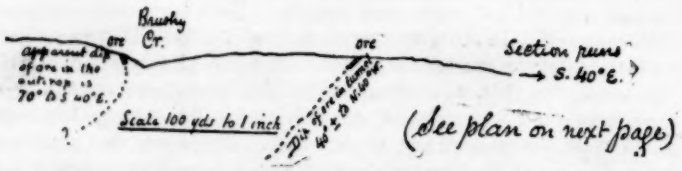

Plan of the outcrops and diggings on the Trueblood Plantation
Scale 1 inch to 100 yards
Brushy Creek
Strike of the bed N.50°E.
Tunnel to strike the bed.
Pit from which solid ore has been taken on the surface.
TRUE BLOOD
PLANTATION
Solid ore outcropping with apparent dip of 70° to the S 40°E.
Sawyer's House.
The tunnel is driven in 36 yards, S.38°W.
Dip of ore bed in tunnel about 40° to the N.40°W.
The rocks cut in the tunnel were:
6 ft. Decomposed granite & mass of clay
3 ft. Hard V massive micaceous fine grained
38 ft. Soft decomposed " " " "
White decomposed coarse grained granite
2 ft. Hard white coarse grained granite
33 ft. Hard granite and Syenite.
10 ft. Disintegrated gneiss.
Ore obscured by mass of rock.

FIG. 12a.

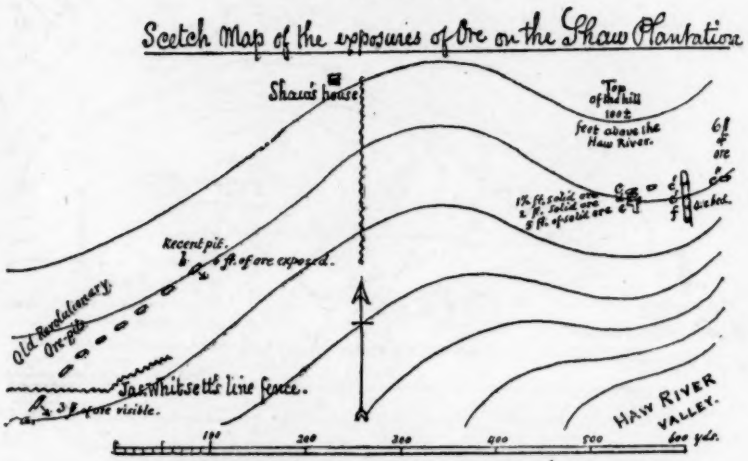

Brushy Cr.
ore
ore
apparent dip of ore in the outcrop is 70° to S 40°E.
Section runs → S.40°E.
Scale 100 yds to 1 inch
Dip of ore in tunnel 40° to N.40°W.
(See plan on next page)

But nowhere do the number and irregularity of the ore-beds show more plainly than in the openings made on the Shaw range, and Shaw plantation, as will be seen by the plans and sections of the old revolutionary diggings, and the late shafts and trial trenches opened on that property, as given in Fig. 13, etc., further on.

On this Shaw Plantation, where three or four distinct and parallel beds have been opened, as seen in the preceding chart and diagrams, the direction of the bed changes somewhat, being N. 30° to 35° E., at the "Old Revolutionary Pits," and more nearly easterly at the openings recently made by the Company. The whole course tested amounts to over half a mile. The beds at the outcrops vary in thickness from one to six feet. At c'' the ore-bed is full 6 feet across solid ore—a very green, chloritic, mica-slate rock-ore. In this run of 800 yards, there are, *apparently, two hundred thousand tons above water-level,* in the one six-foot bed.

The ore is good. The outcrop runs along the top of a hill, about one hundred feet above the bottom of the Haw River Valley, and can be tunnelled into at that depth. There are apparent variations in the

FIGS. 13, 14, 15, 16.



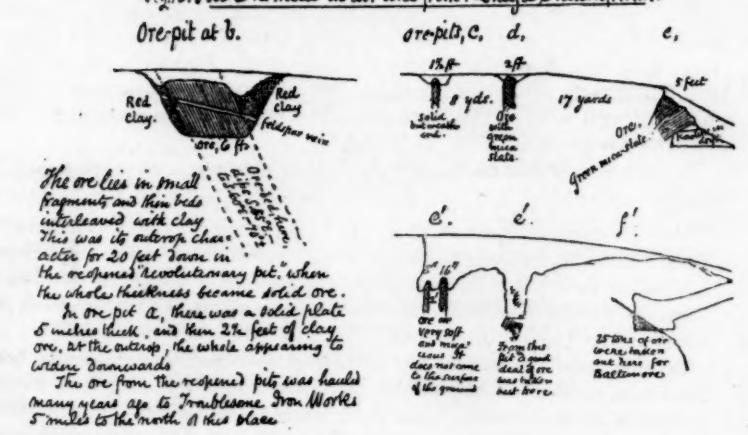
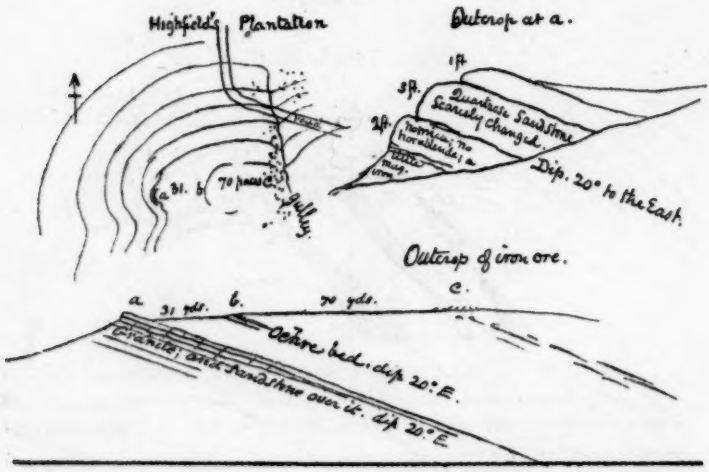


Fig. 16. Pits 3½ miles in air-line from Benaja Station, P.R.R.
Ore-pit at b.
Ore-pits, c, d, e,
Red clay.
Red clay
Feldspar vein
Ore, 6 ft.
The ore lies in small fragments and thin beds interleaved with clay. This was its outcrop character for 20 feet down in the reopened "revolutionary pit," when the whole thickness became solid ore.
In Ore-pit a, there was a solid plate 5 metres thick, and then 2½ feet of clay ore, at the outcrop, the whole appearing to widen downwards.
The ore from the reopened pits was hauled many years ago to Troublesome Iron Works 5 miles to the north of this place.
1½ ft.
2 ft.
8 yds.
17 yards
5 feet
Ore
Green micaceous slate
c'. d'. f'.
16°
Ore not very pure and many veins of clay run to the surface of the ground
From this pit a good deal of ore was taken out for

dip, some of the outcrops seeming to be vertical, whereas the principal part of the mining has already shown a distinct dip towards the south-east and south. In pit *f* of the chart, the dip seems to be scarcely 40°.

The Highfield outcrop shows that the ore beds lie in this Shaw range, at a much gentler angle than in the Tuscarora range; thus:—

FIG. 14.



The distribution of pieces of ore over wide sections of the outcrop of the ore-belt, is a notable thing. Along certain narrow lines inside the belt, are to be seen multitudes of fragments lying on the ground, which have been left behind when the rest of the rock has been mouldered and washed away. And sometimes these fragments are a foot or more in diameter, although commonly smaller. Formerly, the ground was abundantly covered with them, but they were the first ore sought and used, and most of the large pieces and patches have disappeared during the war years of 1861, '2, '3 and '4.

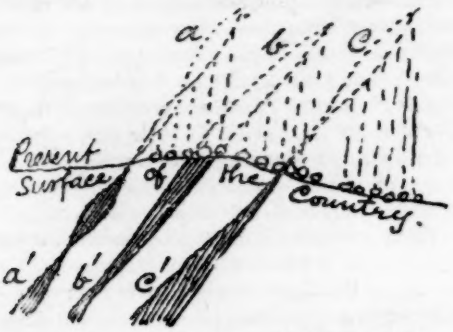
Large pieces on the surface are the best evidence we can possess (in the case of unexplored ground) that the beds are of a good size, for they have come from those portions of the beds (a, b, c, &c., in the accompanying diagram, (fig.15), which have been destroyed in the general lowering of the surface of the country. There is no reason why the parts of the beds left under the present surface (a′, b′, c′, &c.), should not yield as large masses as the parts a, b, c, which have been mouldered away.

2. *The Size of the Ore Beds* varies as much as their number. They consist of strings of lens-shaped masses, continually enlarging and contracting in thickness, from a few inches to six and eight feet. The principal beds may be safely estimated on an average of four feet, or 176,000 tons to the mile, with an average breasting of 60 feet above water level. It is needless to say that an equal amount would exist beneath water-level, for every sixty feet sunk on the bed.

3. *The Quality of the Ore.*—It belongs to the family of the Primary Ores. It is very similar to the New Jersey ores which are so extensively

mined for the furnaces on the Lehigh river. It is a mixture of magnetic crystals, and specular plates of sesquioxide of iron, with quartz, feldspar and mica, in a thousand varying proportions. Sometimes the bed will be

FIG. 15.



composed of heavy, tight, massive magnetite (or titaniferous magnetite), with very little quartz, &c. At other times the bed will be composed of a loose, half-decomposed mica slate, or gneiss rock, full of scattered crystals of magnetic iron.

The ore is, in fact, a decomposible gneiss rock, with a varying per centage of titaniferous magnetic and specular iron ore, sometimes forming half the mass, and sometimes constituting almost the whole of it.

The compact varieties will yield between 50 and 60 per cent. of pure iron, as in the case of the ore now being mined in the Sergeant Shaft, near the Forges. Mr. Frazer's analysis of this ore is as follows :

Magnetic oxide.....73.56.....[Iron.....53.27 p. c.]
Titanic acid.....13.58.....[Titanium.....6.62 p. c.]
Residuum of quartz, &c.....12.86—with a trace of sulphur.

The specimen was obtained from the tunnel, a hundred feet beneath the surface, and shows an intimate mixture of crystalline titanic ore, magnesian mica, a little hornblende, a little labradorite, and a little specular iron.

This kind is difficult to smelt in the high-stack blast-furnace ; but makes the best iron in the world when smelted in the Catalan forge ; and is of great value for the lining of puddling furnaces. It serves the same purpose as the Lake Superior ore, which is brought in large quantities to Pittsburgh, and the surrounding district of Eastern Ohio and Western Pennsylvania, for lining puddling furnaces, and to mix with poorer ores in the blast-furnaces. Formerly, in the E. Ohio Mahoning district, the mixture was : one-fourth Lake Superior, one-half coal measure ore, and one-fourth mill cinders. Since the organization of the Lake Superior Iron Ore Trade, sufficient quantities come forward to enable the iron masters to mix one-half Lake Superior. The Sharon Furnace on the Beaver river runs wholly upon Block Coal and Lake Superior Ore. The titaniferous magnetic ores of the Ottawa region, in Canada, are also brought by a long and expensive route to Pittsburgh, to mix with Pennsylvania

ores. These Canada ores are of the same geological age, and of the same mineral character, as the Tuscarora ores under consideration.

Trial of the ore has been made by Mr. Nathan Rowland, at his works in Kensington, Philadelphia. Five tons were forwarded for trial as lining to puddling furnaces. Mr. Rowland expressed his opinion that it stood up three times as long as the Champlain ore, which he uses for that purpose. The difference is due to the superior compactness of titaniferous magnetite over that of pure crystalline magnetite.

I have said above, that the Tuscarora ores are essentially like those of Northern New Jersey. I referred to their age, situation, consistency, and general composition. But they have a peculiarity; they hold a notable per centage of *titanic acid*. The New Jersey ores seldom possess this property, and, in any case, only in a low degree. The Canada ores, and the ores of South Sweden, hold large quantities of titanic acid; even as much, sometimes, as between 30 and 40 per cent. A small—a very minute—quantity of titanium in pig-iron is believed to add greatly to its value, increasing its hardness and firmness, and its ability to stand wear. The Canadian ores were introduced to the Pittsburgh iron works for this end. But, seeing that almost all the titanic acid in any iron ore passes off in the slag, leaving a very small quantity to unite with the pig metal (sometimes in scattered crystals), it follows, that ores, which have an excessive quantity of titanic acid, cannot afford a high per centage of pig metal. It is much better to have an extra 20 per cent. of silex and alumina, potash or lime, in the ore, than an extra 20 per cent. of titanic acid; for these will make the ore easy to smelt, whereas the titanic acid makes it difficult to smelt; requiring a much higher heat in the stack to decompose than does oxide of iron.

There is no question that titanium in iron ore favors the production of iron peculiarly suited to conversion into steel. The English steel trade has always largely depended on Swedish iron; and I believe that the titaniferous ores of the United States (and they are far from abundant,) will become annually more and more valuable, on account of the increasing demand for the best iron for steel-making purposes. If these ores were smelted in large quantities in first-class anthracite furnaces, I do not think this particular value would appear; the small Swedish blast furnace must be used, or the Catalan forge.

Although the action of titanium upon iron in metallurgy is an obscure subject, something is known of it by actual experience.

J. H. Alexander, of Baltimore, in his report on the Manufacture of Iron, gives analyses of certain cinders, among which is one obtained in the smelting of a primary iron ore, containing, he says, 11 (eleven) per cent. titanic acid: the analysis is as follows:—

Silica	31.1	*Oxide of Titanium*	9.0
Magnesia	34.2	Protox. manganese	4.4
Lime	14.1	Protox. Iron	1.0
Alumina	8.9		

The ore, he says, was hard to smelt, and the pig-iron hard to work, but when properly made, is peculiarly adapted to the manufacture of steel.

The explanation is as follows:—Titanic acid will not combine readily with either the acid or the alkaline oxides. In every ton of ore (holding 10 per cent. of it) 320 lbs. of this neutral stuff exists, or (1½ tons of ore to 1 ton of iron) 330 lbs. of it in every ton of iron. If only 1-10 of this (or 33 lbs.) remains in the furnace, the gradual accumulation blocks it up. The only solvent of it are the double silicates of iron and lime, or iron and alumina and lime, or iron and potash and lime, &c. To make these double silicates, we must *waste* a good deal of iron. But the one object of the blast furnace is to *save* all the iron, and the best cinder is that which has no iron left in it, all the iron of the burden having gone down into the hearth as pure metal (with enough carbon to make it fusible). The Catalan forge, on the contrary, wastes iron, and its cinders are so rich in iron, that they are often worked over again; hence, titanic acid is carried off, and does not obstruct the hearth. The forge fire is, therefore, the best to reduce titaniferous iron ores. But the blast furnace can smelt them also, if the heat be kept low, and some of the iron be allowed to go to waste in the cinders, to carry off the titanic acid and cinder mass. The object then, must be to make the utmost quantity of the most fusible cinder; therefore, a blast furnace running on titaniferous ores, should not be fluxed by pure limestone, pure clay, or pure sand, but with ferruginous clay, ferruginous slate, or ferruginous limestone. These fluxes will dissolve titanic acid *at a low heat.* To get gray pig iron, the cinder must be abundant; to get white forge metal, but little flux is needed in comparison, the ore itself being wasted to form cinder. This *white iron with a large amount of carbon in it,* is just the metal from which German steel is manufactured. A high stack and a small hearth, like the Styrian furnaces, and ferruginous fluxes, are the best for titaniferous ores.

Osborne says (page 475), that Mr. Henderson writes him that the Norwegian ores are successfully used at Norton, England, on a plan invented by John Player, although they contain (by one anlaysis)

Titanic acid			40.95
Perox. iron	22.63	}	51.59
Protox. iron	28.96	}	
Magnesia	4.72	}	7.81
Alumina	2.11	}	
Silica	.42	}	
Protox. mang.	.56	}	
			100.35

being smelted in small furnaces with 1000°F temperature of blast, 2 tons of coal to 2½ tons of ore, 15 cwt. of limestone, 10 cwt. basalt rock.

"The iron becomes titanized, and is found to be exceedingly strong, and is used in Europe for armor plates, commanding *three times the price* of ordinary pig iron. The tensile strength of the resulting wrought iron, when puddled, is about 52½ tons to the square inch. There is very little carbon in the pig-metal produced, and *being almost steel,* in puddling it requires but half the time of ordinary pig metal."

Muchat's Steel is a *titanic iron,* with the peculiarity of being sufficiently hard after being heated red hot and forged, not to require tempering,

but is comparatively brittle. Its color is not white, but has a tinge of straw color light brown.

The *lighter and looser varieties* of the Tuscarora ores have a lower per centage of iron in them, but will work more kindly in the blast-furnace. I had Mr. Frazer make me an analysis of a piece of outcrop ore from the Highfield plantation. It gave: Magnetic oxide, 44.53 [metallic iron, 32.25]. These varieties make equally good iron, and iron as well adapted to the manufacture of steel.

The hard and soft varieties of ore occur often within a few hundred yards of each other; as, for example, on the Widow McCristen's plantation (14-15 miles), where the soft outcrops are seen on the hill opposite the house, and the hard ore lies in large chunks on the hill, south of the swamp. I append Dr. Genth's analysis of specimens from the two places, made at my request:

1. Massive ore from Mrs. McCristen's Plantation. The analysis was so unexpected in its character, that Dr. Genth suspected some error, and repeated it, but with the same result. The small amount of titanium shows the varying nature of the deposits. The percentage of iron is also low for this kind of ore:

Iron	33.97 p. c.	
Titanium	1.60	[=2.63 p. c. titanic acid.]
Ratio of Titanium to Iron	1 : 21.24.	

2. Soft micacious ore from the same locality. The high per centage of both iron and titanium in this ore was equally unexpected, and was very gratifying; for it will be seen from fig. 7, on page 17, that there is a total breadth of *ten feet* to this outcrop, in a space of twenty-seven. If any of the beds unite descending, the yield of ore will be great.

Iron	43.47 p. c.	
Titanium	9.79	[=16.06 p. c. of titanic acid.]
Ratio of Titanium to Iron	1 : 4.44.	

It is made known by the Canadian geologists that the constituents of some of these primary ores are combined in such a way as to approximate the rock to a diorite, or green-stone trap. Now, such a rock is seen on several of the Company's leases; and especially on the Shaw, and other plantations two miles southeast of it. Sometimes the ore-bed itself become dioritic.

It will not be amiss to add other analysis of these Ores.

Ore Analysis, by F. A. Genth, in 1868.

Magnetic oxide	79.78	= iron..... 57.77
Titanic acid	12.08	
Oxide manganese	0.28	
Chrome oxide (trace of Vanadium)	0.32	
Silicic acid	0.75	
Alumina	4.62	
Magnesia	2.04	
Lime	0.13	

Ore Analysis, by J. B. Britton, June 3, 1868.

Iron (protoxide) iron.....21.20 + (peroxide).....39.40		—60.60
Oxygen, with the iron in said 60.60		23.67
Mixed Sesquioxide, magnetic, &c		84.27
Titanic Acid		4.95
Containing other insoluble matter		3.25
Alumina		4.81
Lime		0.24
Moisture		1.66

No phosphorus, and a doubtful trace of sulphur.

NOTE.—I have changed the order and wording of this analysis, to suit the others for comparison.

Ore Analysis by C. Elton Buck, Wilmington, Del., Oct. 31, 1868.

Magnetic Oxide of iron	82.68	[—Iron 59.95]
Titanic Acid	8.72	
Ox. mang.....0.42. Sesq. ox. chrom.....0.40		0.82
Silica	1.89	
Alumina	3.93	
Lime	0.17	
Magnesia	1.36	

Another, June, 1869.

Magnet ox. iron	81.30	[—Iron 58.52]
Titanic Acid	12.32	
Ox. Mang. and Ox. Chromium, and Sulphur		traces.
Silica	1.04	
Alumina	3.87	
Lime	0.64	
Magnesia	0.49	
No phosphorus		
Moisture and loss	0.34	

Ore Analysis, by A. A. Fesquet, Nov. 12, 1868.

Metallic iron		60.41
Titanic acid	8.65	
Sesq. ox. Chrom.....0.83 Sesq. ox. Manganese.....0.12	0.95	
Silica	1.50	
Alum.	2.90	
Magnes.	2.02	
Lime	0.75	

No trace of Sulphur.

A mere trace of Phosphorus.

Analysis made by pulverizing several hand specimens, and mixing them first, to obtain an average result.

Ore Analysis, by A. A. Fesquet, July 6, 1869.

Specimen highly magnetic, and almost without moisture.

Metallic iron in combination with	57.30	79.14
Oxygen (calculated for peroxide)	21.84	
Titanic Acid		13.74
Silica	0.52	
Alumina	4.50	
Magnes	0.54	
Lime	0.72	
Sesq. Mang	0.69	

Trace of Chromium.

No sulphur ; no phosphorus.

Ochre Analysis, by A. Fesquet, 1869.

Sesqui. ox. Iron	19.43	[containing met. iron 13.60]
Silica	34.12	
Alumina	33.21	
Water, &c., &c	13.24	

In this ochre, which forms large beds on the outcrops of the more ferruginous feldspathic rocks, one has a superior flux for any heavy burden ore, especially for a close titaniferous ore. The ochre must become a fluid double silicate, without robbing the ore, and will carry off the titanic acid in excess.

One of the constituent elements of the whole formation is Ochre, in beds of various sizes. What the exact geological relationship of these ochre beds to the magnetic ore-beds is, I do not know. But the ochre outcrops seem to be always in the immediate vicinity of the ore-beds. The largest exhibition of ochre which I saw is on the J. Somers Plantation on Brushy Creek. Here an ochre bed twenty feet thick rises, nearly vertical, out of a gully in a hillside covered with small pieces of fine compact ore.

Bar-iron Analysis, by A. A. Fesquet, April 4, 1870.

"The samples of iron bars which you gave me to analyze have the following composition:

Metallic iron [includes what iron is combined with oxygen]	99.38
Insoluble calcined substances, [Silica, &c]	0.15
Carbon [and oxygen ?] [by difference]	0.47
Also, a trace of Titanic acid.	
	100.00

"I would judge from the nature of the samples, and former analysis, that the proportion 0.47 per cent. under head of Carbon, &c., is too considerable to be formed by Carbon alone, and comprises, very likely, carbon and oxygen. Therefore I would judge that part of the impurities is from oxide of iron, and the remainder from slag, which I have ascertained experimentally. In other words, the impurities are due to a highly basic slag, which cannot be expelled or squeezed out by the hammer and the rolls."

NOTE.—The above bars were rolled (from blooms of N. Carolina ore) by Jas. Rowland & Co., not cut and piled.

North Carolina Blooms made into Steel by the Martin's Process.

In January, 1871, Mr. A. A. Fesquét assisted at the conversion of ten tons of North Carolina blooms into steel, at Cooper & Hewitt's Works, Trenton, N. J.

The blooms were some of the first made at the Tuscarora Forge fires, rough and variable in size and quality, and weighing from 150 to 225 lbs.

Mr. Fesquét thus reports;

The Siemens-Martin's Process consists in mixing steel scraps with pig iron. The Carbon of the pig iron reduces the iron oxidized by the flames; keeping watch, as it were, over it, and preventing the perpetually forming oxide of iron from forming a cinder with the silica of the furnace lining.

The charge being melted, it remains exposed to the flame until, and even after, all the carbon is burned off.

The exact moment is known by a series of samples being taken out, hammered and bent, hot.

If the samples be red short, Franklinite iron is added to restore enough carbon to remove the oxygen from the iron.

After one or two stirrings the metal is run into moulds.

The North Carolina blooms took the place of the steel scrap. The cast iron used was West Cumberland (English) pig, nearly free from sulphur and phosphorus, and with enough silicon and carbon to fit it for Bessemer use.

At the moment of complete decarburation a sample was taken. It was slightly red short. An analysis showed that the red-shortness was due to a minute proportion of oxide of iron and cinder, which had not been expelled because of the pasty condition of the decarburetted metal. Percentage of carbon less than 1-1000th part.

Franklinite was added; the metal became fluid, and was run into moulds.

The ingots were sound, and presented large crystals, of a clean gray color.

A sample from one was perfectly malleable, without a trace of hot or cold shortness, without a flaw, and homogeneous to all appearances. The large crystals were condensed under the hammer. The fracture was not jagged, and resembled that of cast steel of some degree of condensation and hardness.

In a word, *this* steel was malleable, homogeneous and tough, like the best steel produced in any other way.

Tried at the forge fire (by the same workman), it seemed to bear more heat for welding and hardening than will the ordinary steel (with a corresponding proportion of carbon).

Less carbon is necessary in the case of titanium steel than in the case of common steel, to arrive at the same hardness.

In the rolls, this steel manifested no difficulties, according to the testimony of Mr. Slade of the Trenton Works.

Waste: Three operations, 14,152 lbs. of metal in all; waste, 13.5 per cent.,

exceeding somewhat the waste when steel scraps are used; for the cinder in the blooms has to be purged off in the process, and secondly, the almost purely metallic titaniferous bloom iron is much harder to melt than scrap steel; is longer exposed therefore to the flame, and therefore wastes more. By adding pig metal this evil will find a remedy.

The peculiar qualities of this steel will no doubt be intensified when its own titaniferous pig metal is used with its titaniferous forge blooms.

A dose of Franklinite may yet be necessary. Mr. Fesquét thinks it acts by giving up carbon. He suggests, however, that possibly it acts through manganese; but as nearly all the manganese goes off in the slag, he thinks its peculiar use is to keep the cinder fluid, and taking the iron's place in the cinder.

Stated Meeting, July 21, 1871.

Present, three members.

Mr. Chase in the Chair. Secretary, Mr. Lesley.

A photograph of Dr. O. Seidenstricker was received for the Album.

Letters of envoy were received from the Senkenburg Society, at Frankfort, the I. Akad. Vienna, and the Society at Riga.

Letters of acknowledgment were received from Dr. Bunge, of Greiswald; Herr Tunner, of Leoben; Dr. Rokitansky; the Zool. Bot. Soc., Vienna; Munich Observatory, and Chicago Academy.

A letter was read from Mr. Putnam, of Salem, the consideration of which was postponed.

Donations for the Library were received from the R. S., Tasmania; I. A., Vienna; Z. B. S., Vienna; Senk. S., Frankfort; R. Danish S.; R. Com. Geol., Italy; Capt. Settimanni; School of Mines, Paris; R. Ast., R. Geogr. and Chem. SS., London; Nature; San Fernando Observatory; Essex Institute; Mass. Hist. S., Am. Antiq. S., Camb. Mus. Com. Zool., J. H. Trumbull, Sill. Jour., Mrs. Willard, N. Y. Lyceum, Frank. Inst., Acad. N. S., Coll. Pharmacy, Med. News, Dr. Rushenberger, Isaac Lea, Peabody Inst., and Secretary Robeson, of Washington.

The death of Mr. Eugenius Nulty, at Philadelphia, on the 3d inst., aged about 83 years, was announced by the Secretary.

Mr. Chase communicated a Note on the Pluvial Indications of the Metonic and Sun-spot Cycles.

Pending nominations 677 and 678 were read and balloted for, and the following named gentlemen declared duly elected members of the Society:

Prof. Cleveland Abbe, Signal Ser., War Dep't, Washington.

Mr. Benj. Chew Tilghman, of Philadelphia.

And the meeting was adjourned.

Stated Meeting, May 19,* 1871

Present 13 members.

Vice-President, MR. FRALEY, in the Chair.

Letters accepting membership were received from Rev. Dr. James McCosh, dated Princeton, N. J., May 4th, 1871; Prof. E. B. Andrews, dated Columbus, Ohio, May 4, 1871, and Dr. T. A. P. Barnard, dated Columbia College, N. Y., May 5, 1871.

A Photograph for the Album was received from Prof. Roehrig, of Cornell University.

Letters acknowledging the receipt of the Society's Publications were received from the R. Bavarian Academy, (27, 65 to 67; 75, 76, 81, 82); the Society of P. & N. H. at Geneva, (XIII, 3, 78 to 83); the Physical Society at Berlin, (XIII, 3; 81, 82,) the Boston N. H. S., (XIII, 3, XIV, 1, 81, 82, 83, 84, 85,) and the Library of Congress (XIV, 1).

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*The report of this meeting has been inadvertantly misplaced.

Letters of envoy were received from the Physical Society of Berlin, and Dr. C. Naumann of Leipsig.

A letter was received from Mr. W. Barker, Engraver to the U. S. Mint, presenting to the Cabinet of the Society, a medal of David Rittenhouse, after a bust in the possession of the Society.

Donations for the Library were received from the Geological Institute and Authropological Society at Vienna, the Physical Society at Berlin, Dr. Naumann, the Bavarian Academy, the Zoological Garden at Frankford, the Natural History Society at Geneva, the London Meteorological Office and Board of Trade, and Editors of Nature, the Essex Institute, Boston Natural History Society, American Oriental Society, Franklin Institute, Medical News, Wilmington Institute, Mr. G. W. Shaffer of Savannah, and Dr. Newberry.

The death of Sir John F. W. Herschel, on the 12th inst., aged 79, was announced by the Secretary.

A specimen of the Jenny Jump variegated marble of New Jersey, was laid upon the table, and its geological character was discussed by several of the members present.

The attention of the members was called to Herr Lauth's recent memoir on the Gold Mine Map Papyrus of the age of Seti I., and its interesting points described by the Secretary.

New nominations Nos. 677 and 678 were read.

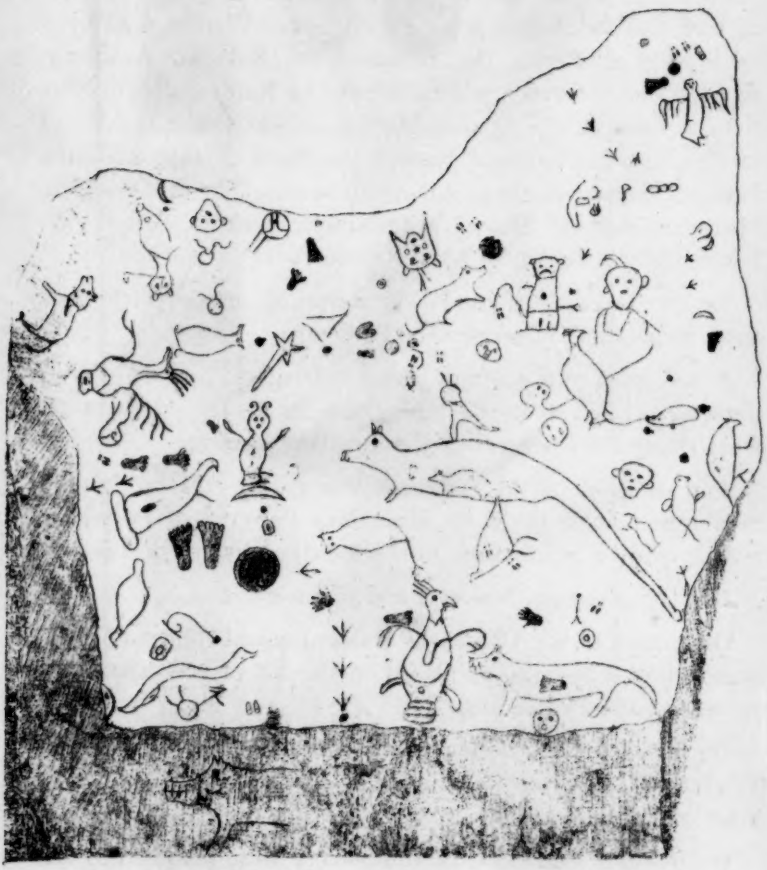
On motion of Mr. Chase, the Meteorological Office at Washington was ordered to be placed on the list of correspondents to receive the Proceedings.

On motion of Mr. Lesley, the American Institute of Civil Engineers was placed on the list of correspondents to receive a set of the Proceedings.

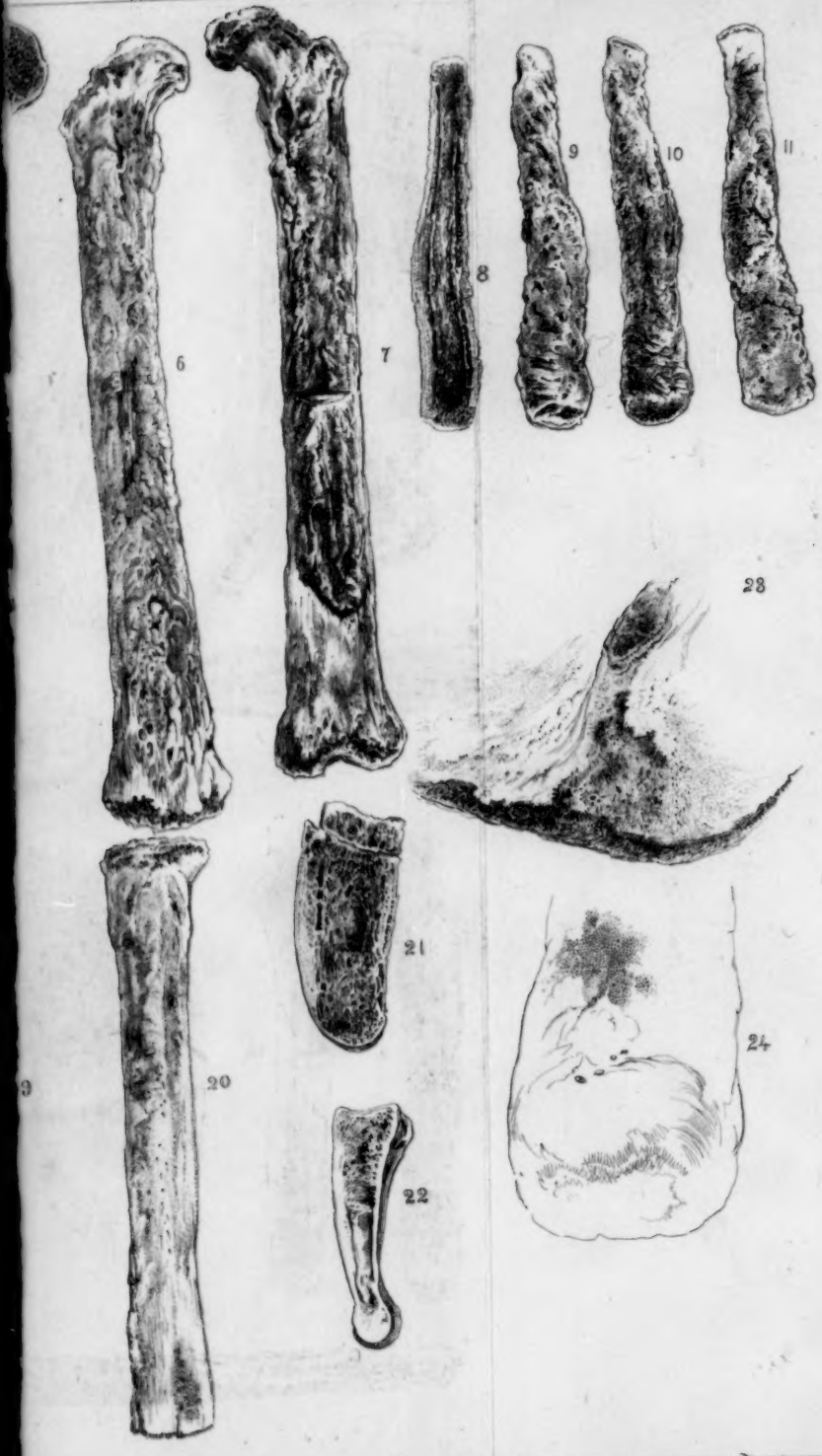
On motion, the thanks of the Society were tendered to Mr. Barber, for his beautiful present.

And the meeting was adjourned.

Indian Sculptures on a rock in South Western Pennsylvania.



H. Faber del. et aqua forte fec.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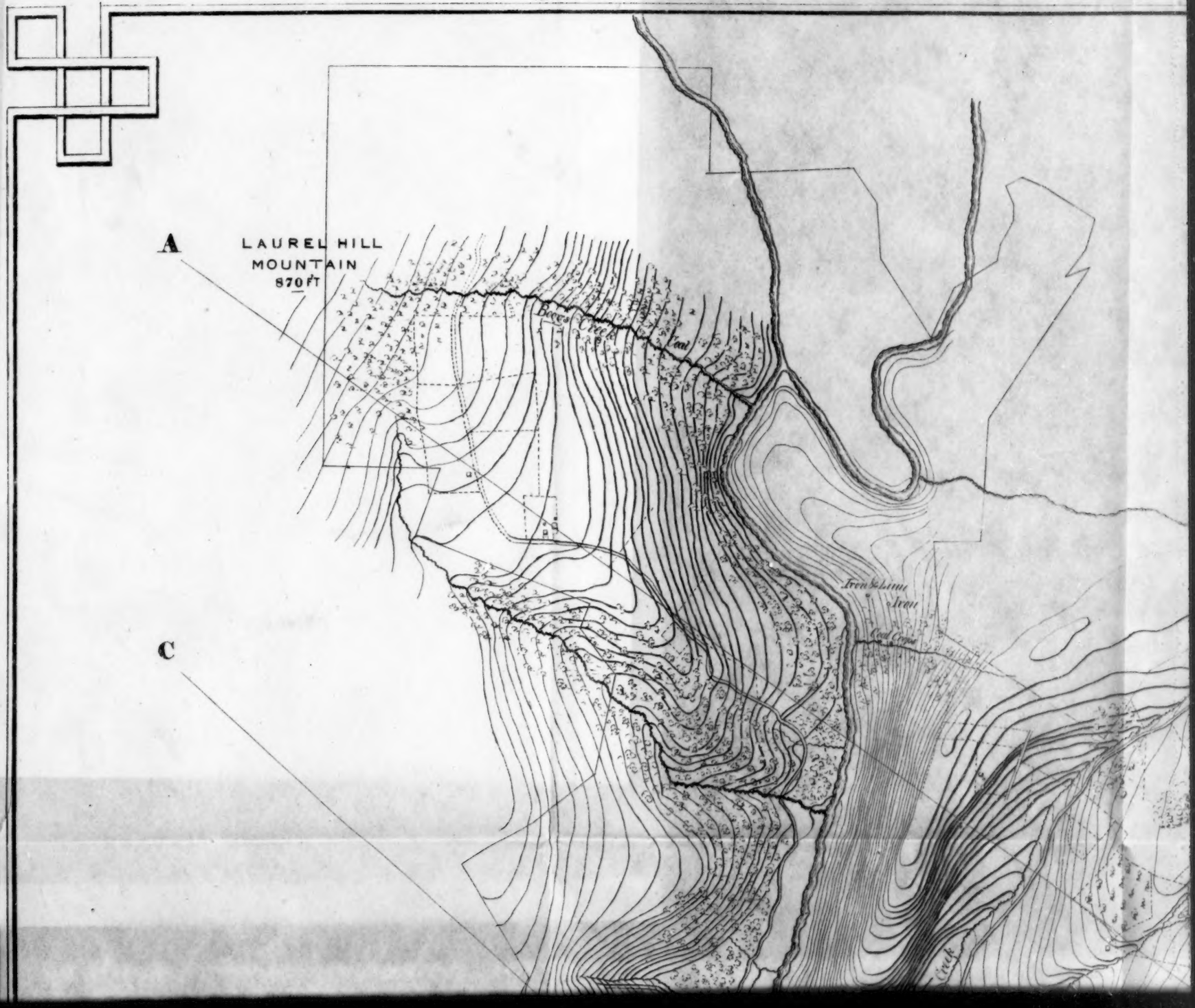
24
22

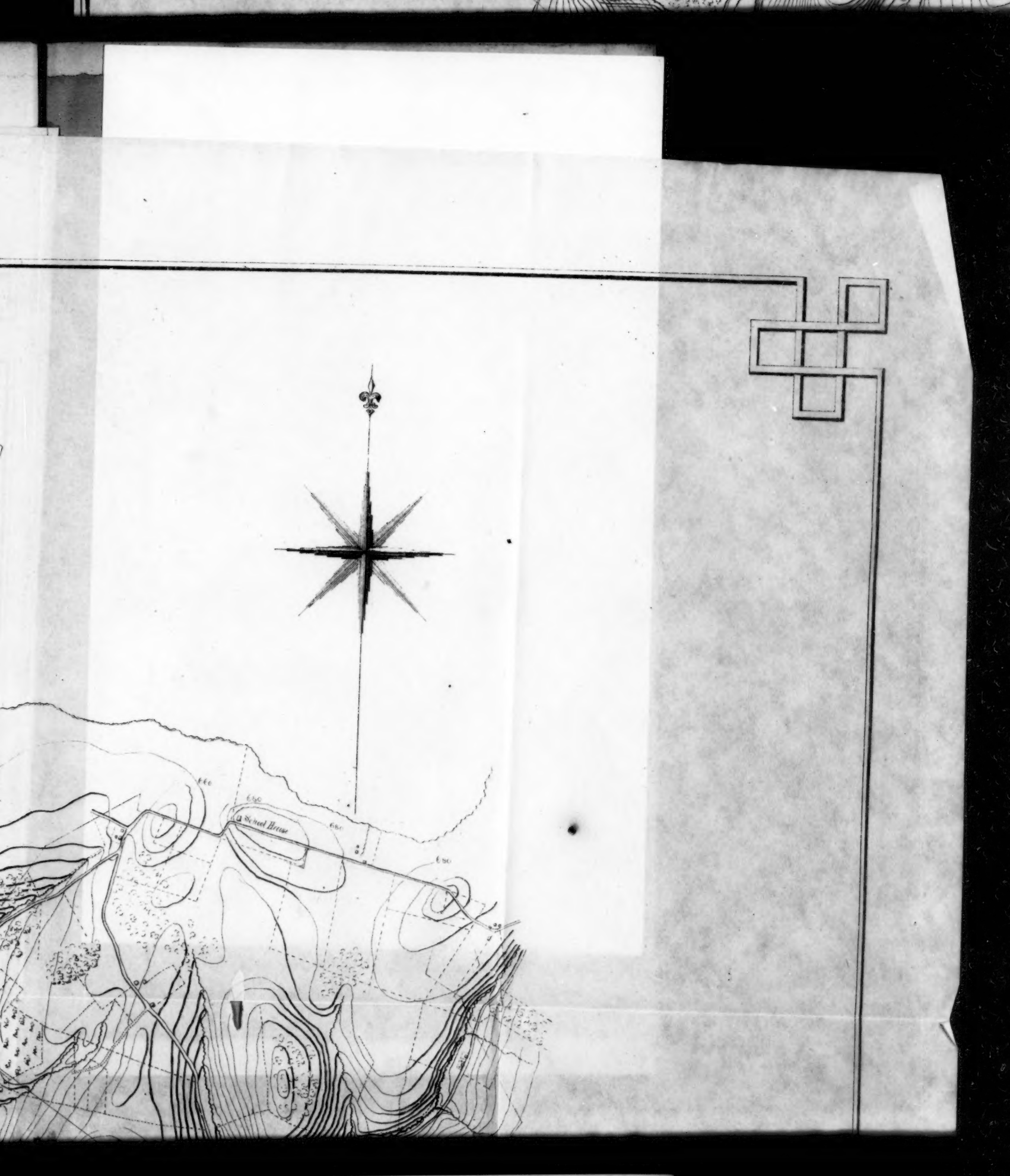
EXPLANATION OF PLATES I. AND II.

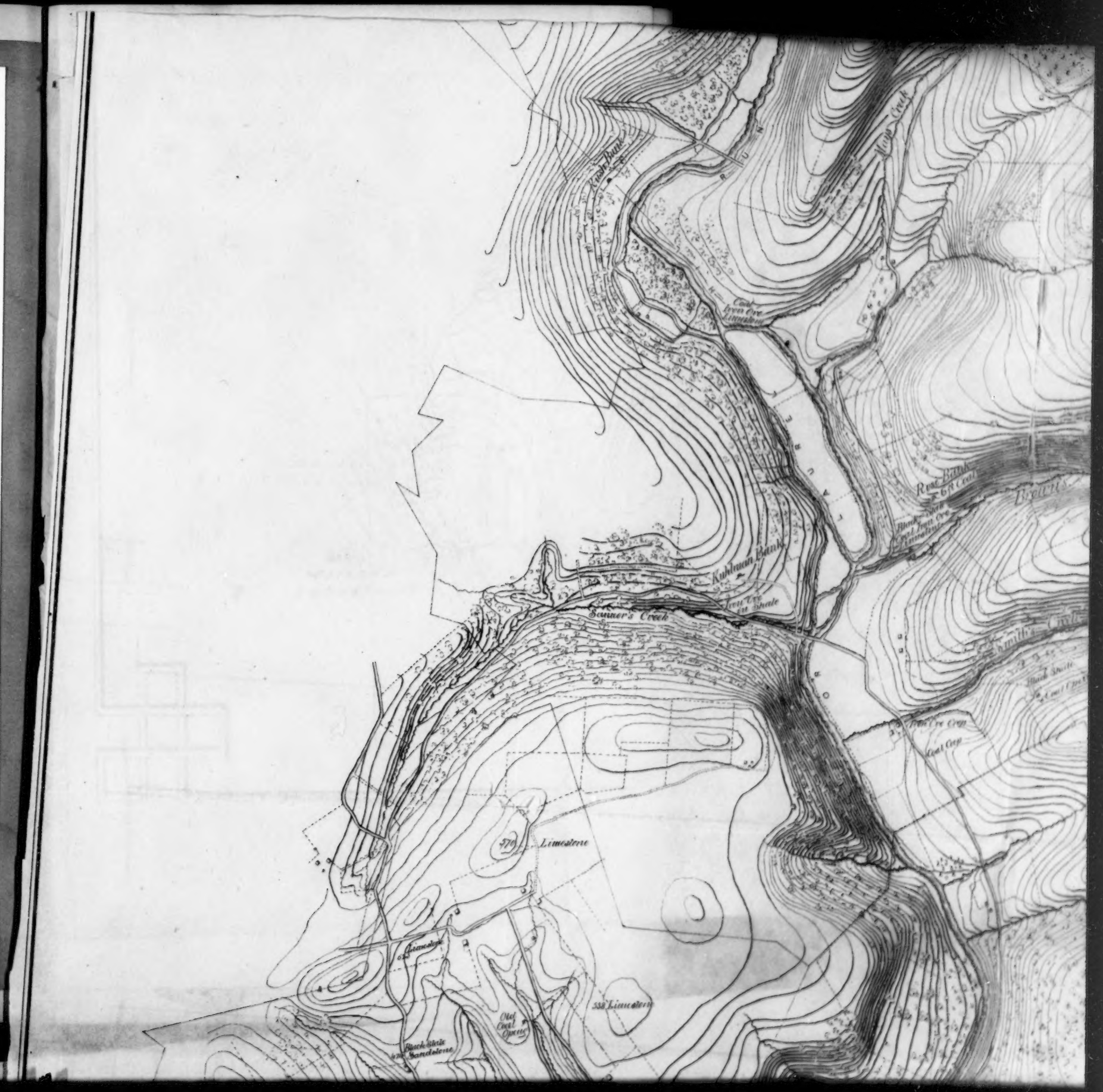
Fig. 1. Posterior surface of right Humerus.
" 2. Anterior surface of left Humerus.
" 3. Section of left Humerus.
" 4. " " natural size.
" 5. Section of left Femur.
" 6. Anterior surface of right Femur.
" 7. Posterior surface of right Femur. The notch about the middle is where a slice was removed for microscopic preparations.
Fig. 8. Section of left Radius.
" 9. Posterior surface of left Radius.
" 10. Posterior surface of right Radius.
" 11. Anterior surface of right Radius.
" 12. Section of left Ilium.
" 13. End of right Clavicle.
" 14. Posterior surface of right Ulna.
" 15. Anterior surface of right Ulna.
" 16. Section of left Ulna.
" 17. " " natural size.
" 18. Posterior surface of right Fibula.
" 19. Posterior surface of left Tibia.
" 20. Anterior surface of right Tibia.
" 21. Section of Phalanx natural size.
" 22. Section of healthy Phalanx natural size inserted for comparison.
Fig. 23. Vertebral end of spine of left Scapula.
" 24. Anterior surface of carpal end of right Radius enlarged.

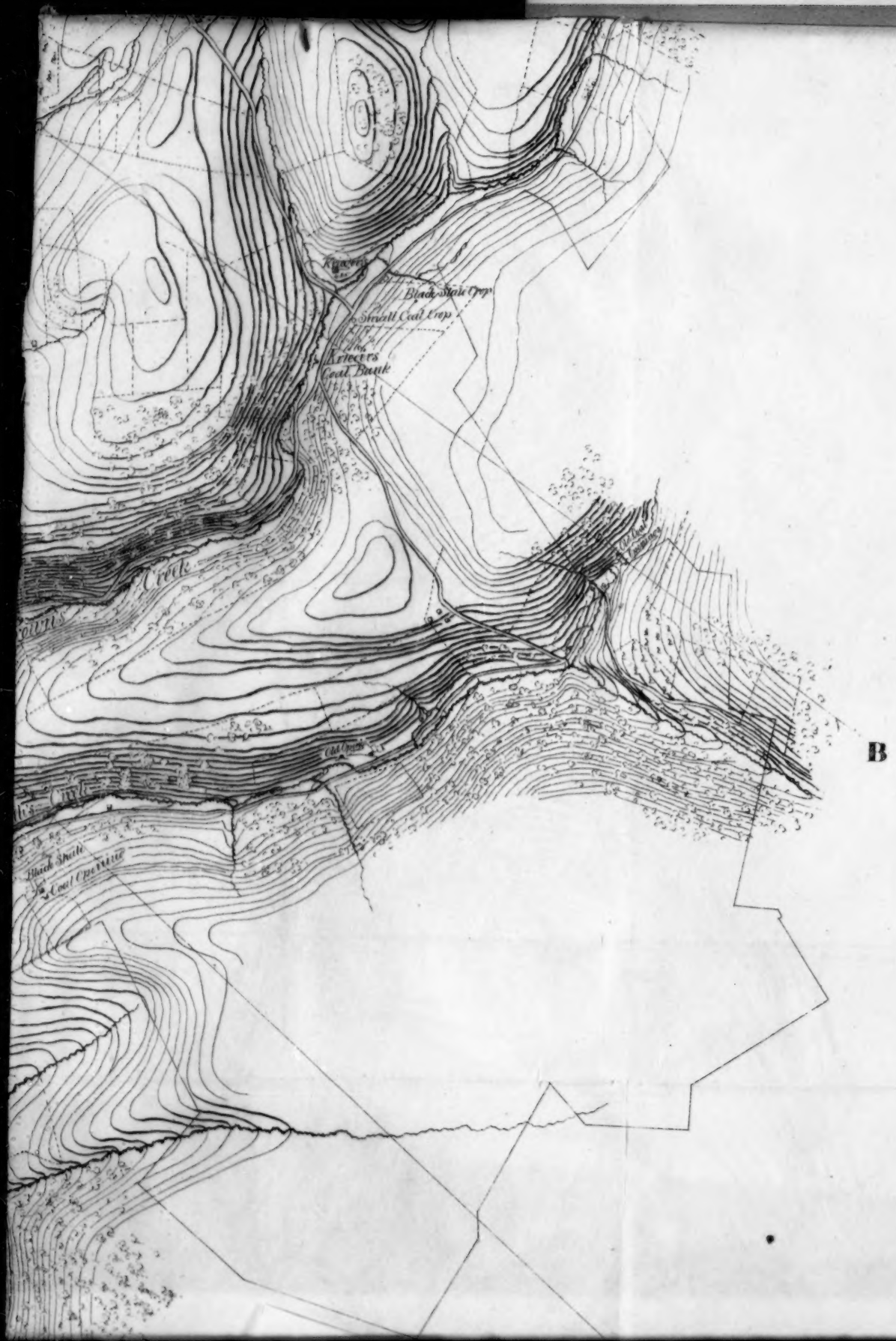
N. B. All the drawings except where noted are on a scale of $\frac{1}{3}$ the natural size.

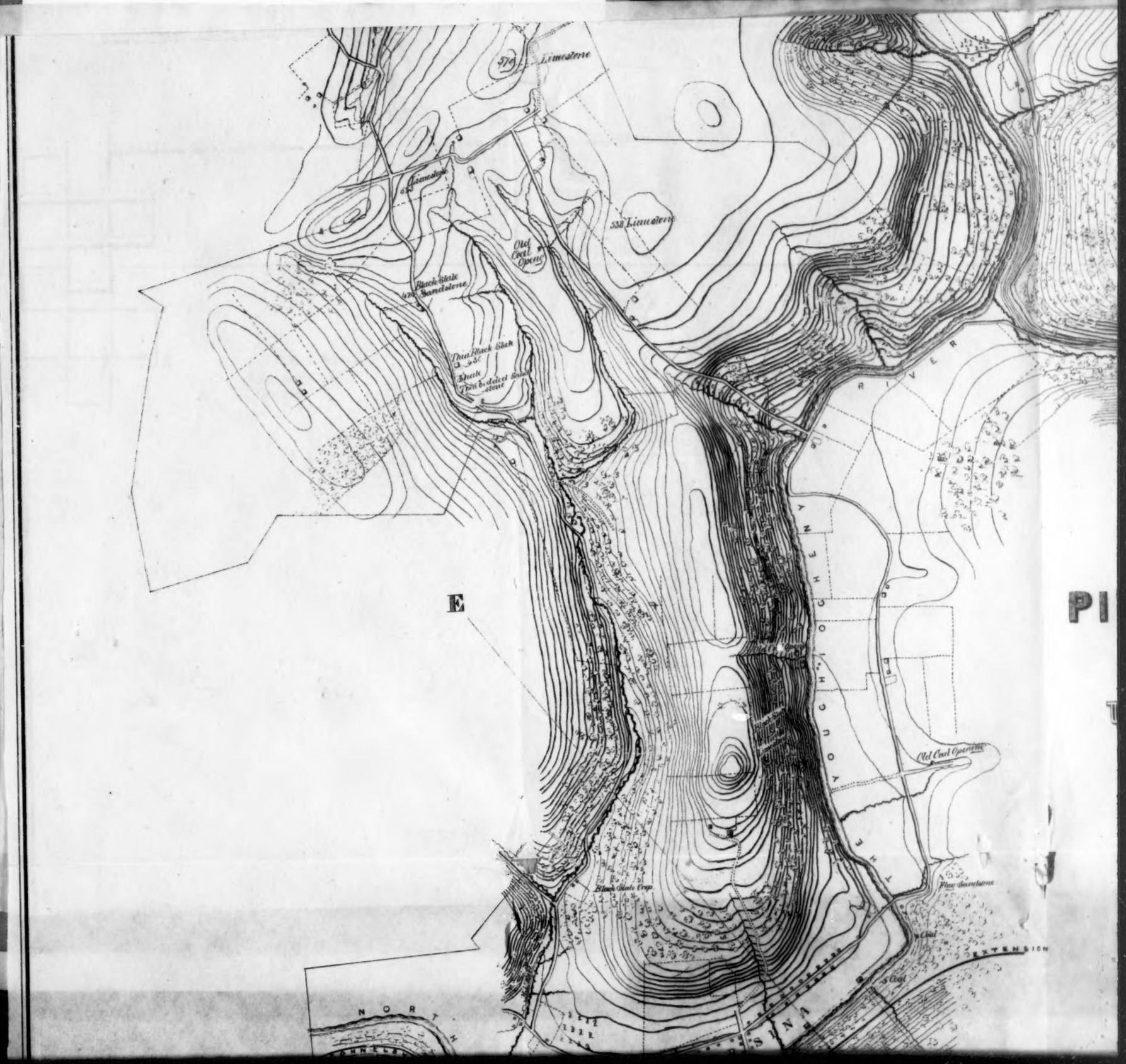

A
LAUREL HILL
MOUNTAIN
870 FT
C

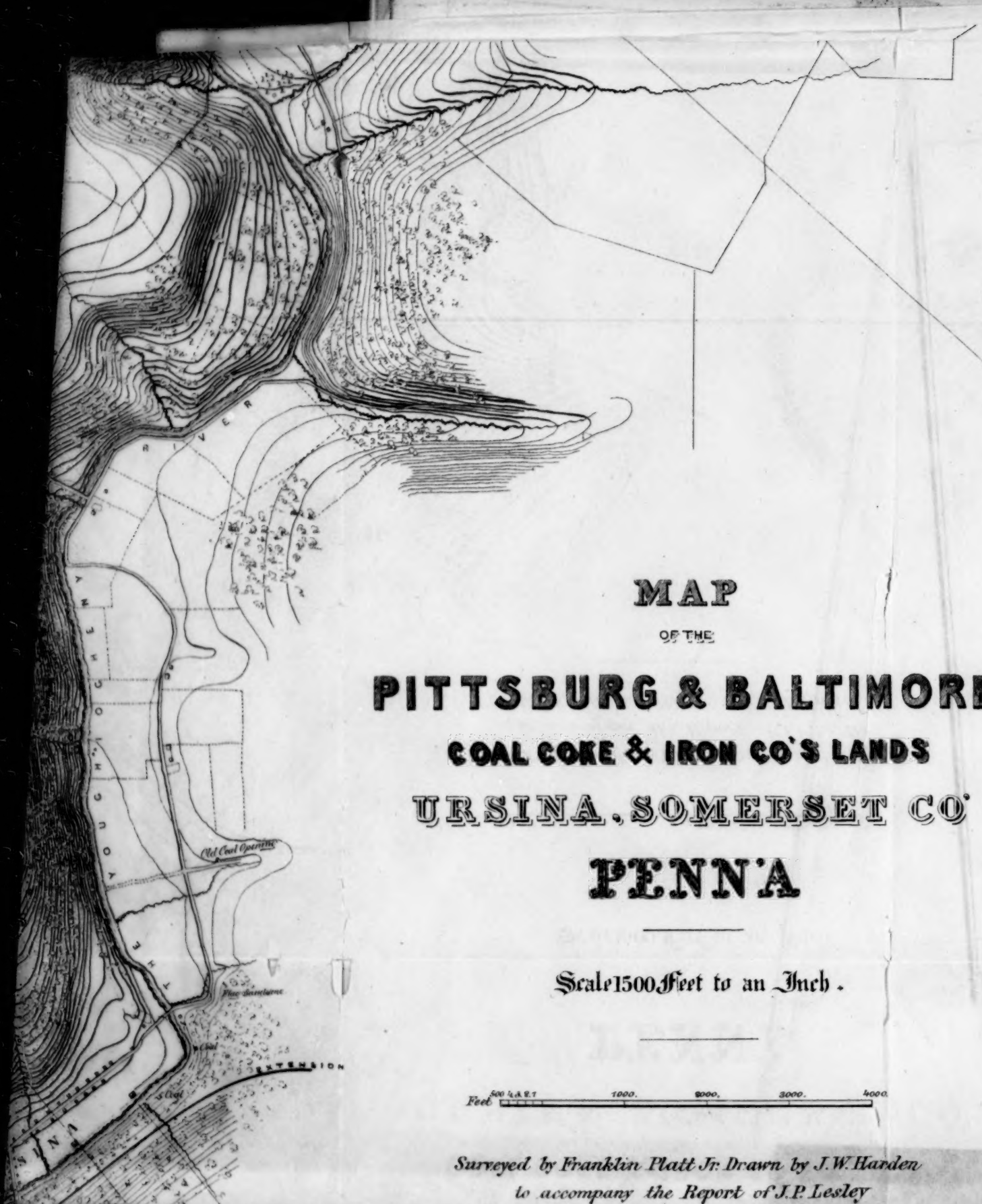
Creek
Coal Creek


660
650
School House
680
650


Rock Bank
Coal Iron Ore Limestone
Kuhlman Bank
Scanner's Creek
Iron Ore in Strata
Limestone
Limestone
Old Coal Opening
Black Slate and Sandstone
Coal Iron Ore Limestone
Iron Ore Coal Cap
Black Slate
Coal Opening


Black Shale Crop
Stinall Coal Crop
Old Coal Workings
Old Coal Workings
Old Opening
Black Shale
Coal Opening
B


Limestone
538 Limestone
Old Coal Opening
Black Slate and Sandstone
Dun Black Slate
Shale
Thin bedded Sandstone
RIVER
Old Coal Opening
Old Coal Opening
Black Slate Crop
Flint Sandstone
Coal
Coal
EXTENSION
NORTH



MAP

OF THE

PITTSBURG & BALTIMORE

COAL COKE & IRON CO'S LANDS

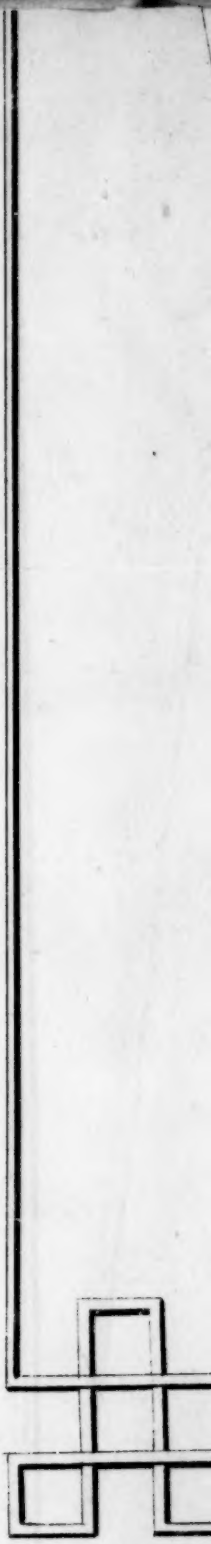
URSINA, SOMERSET CO.

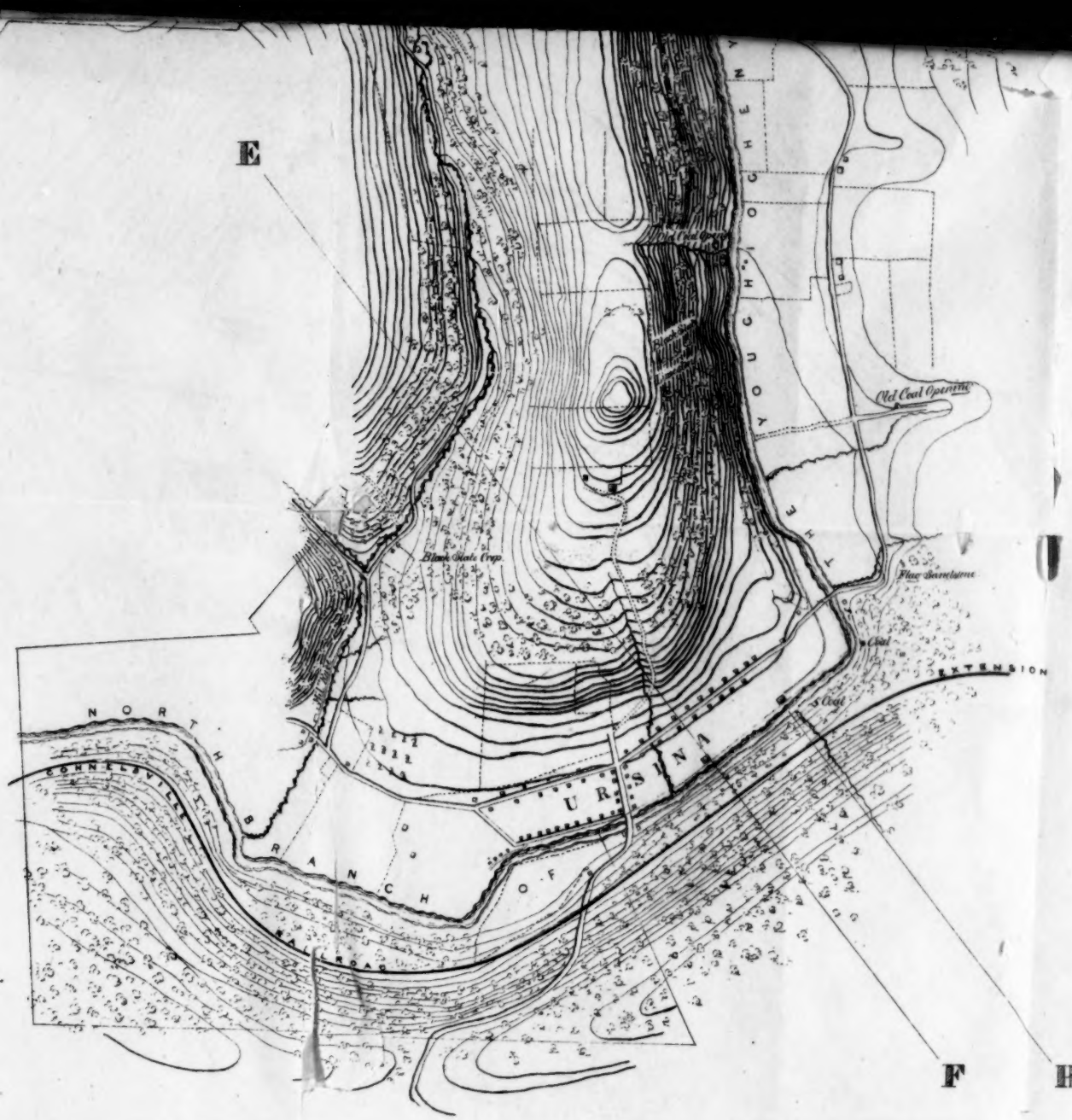
PENN'A

Scale 1500 Feet to an Inch.

Surveyed by Franklin Platt Jr. Drawn by J.W. Harden
to accompany the Report of J.P. Lesley
1008 Clinton Street, Philadelphia

D





PITTSB

COAL C

URSIN

Old Coal Opening

Feet 500 0 500 1000

Surveyed by

to a

100

D

MAP

OF THE

PITTSBURG & BALTIMORE

COAL COKE & IRON CO'S LANDS

URSINA. SOMERSET CO.

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H

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